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ART. XV.—*Observations on the Contrast in the Physical Features and Resources between the Old World and the New World;* by Prof. ARNOLD GUYOT.*

THE appearance of Professor Guyot's work on Physical Geography has been briefly announced in this Journal. The pleasure and profit it is calculated to afford, the importance and novelty of its views, the high intellectual and moral tone that pervades it, impel us to give it a fuller notice. The subject is geography;—not the dry *anatomy* of the earth's surface, of which our common school-books treat;—but geography as taught by Humboldt and Karl Ritter, and interpreted anew with fresh vigor and much originality by our author. The work treats of the physical features of the globe with reference to the history of man. The bearing of its peculiarities of outline, of surface, of climate, and of productions, on the distribution of man and the progress of civilization, is the grand subject in hand; and it is ably discussed with a command of a wide range of facts, and great beauty and fertility of thought. Geography is raised to a level with the higher intellectual sciences, and the Christian spirit infused into it gives it a still more exalted character. The various facts and deductions brought forward one after another, are finally made to concentrate upon the one great idea of man's moral destiny.

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* From a work entitled, *The Earth and Man: Lectures on Comparative Physical Geography, in its relation to the History of Mankind,* by ARNOLD GUYOT, Prof. Phys. Geog. and Hist. at Neuchatel, Switzerland; translated from the French by C. C. FELTON, Prof. in Harvard University. Boston, 1849. xviii and 310 pp. 12mo.

Prof. Guyot commences by explaining Physical Geography as a description of the earth and of its relation to the life upon it. He says, in the course of his illustrations of the subject, "If the Rocky Mountains bordered the eastern coast of North America, and closed against the nations of the East and of Europe the entrance to the rich valley of the Mississippi; or if this immense chain extended from east to west across the northern part of this continent and barred the passage of the polar winds which now rush unobstructed over these vast plains; let us say even less—if, preserving all the great present features of this continent, we suppose only that the interior plains were more slightly inclined towards the north, and that the Mississippi emptied into the Frozen Ocean;—who does not see that in these various cases, the relations of warmth and moisture, the climate in a word, and with it, the vegetation and the animal world would undergo the most important modifications, and that these changes of form and of relative position would have an influence greater still upon the destinies of human societies, both in the present and in the future?" This paragraph exhibits the aim of the work, which the author afterwards more explicitly states as follows—after mentioning the great problems which physical geography offers for investigation: He says, "We shall endeavor to solve these problems by studying, first, the characteristic forms of the continents, the influence of these forms on the physical life of the globe; then the historical development of humanity. We shall have succeeded, if we may have shown to you—

"1. That the forms, the arrangement, and the distribution of the terrestrial masses on the surface of the globe, accidental in appearance, yet reveal a plan which we are enabled to understand by the evolutions of history.

2. That the continents are made for human societies, as the body is made for the soul.

3. That each of the northern, or historical continents, is peculiarly adapted by its nature, to perform a special part which corresponds to the wants of humanity in one of the great phases of its history.

Thus nature and history, the earth and man, stand in the closest relations to each other, and form only one grand harmony."

In carrying out this plan, the author is borne up by his subject, the works of creation, to the Supreme Intelligence whose beneficent designs are so strongly marked around and within us.

The facts of science are not yet sufficient to sustain beyond a doubt all the conclusions arrived at; still the tendency is apparently in the direction in which Prof. Guyot would lead us: and however the reader may differ in some minor points, he will rise

from the work with enlarged views of the earth and its fitness for man's mental and moral development. There are many portions of the volume which we should be glad to transfer to our pages. The chapter on the Relief of the Continents contains views of high importance, which show that the author has studied the world, and not merely a ledge of rocks or an isolated territory. He does not, with the prevalent geological school, regard the elevation of mountain chains as the great events in the physical history of our globe, and the rising of the vast plateaus and plains of the continents as a mere accompaniment; but considers, in view of the amount of evidence in physical geography, the change of level in entire continents as the essential fact, and mountains but the accidents attending the vast changes that have been in progress.

Passing by this and other chapters (or lectures) we cite a portion of Professor Guyot's observations on *the Contrast in Physical Features and Resources of the Old World and the New World*,* referring to the work for the continuation of the subject and the many conclusions deduced.

"The most prominent feature of the arrangement of the continents is the grouping of the two Americas in one hemisphere, and that of the four others in another hemisphere. This division of the continents into two worlds is so evident from the first glance, and is at the same time so convenient in practice, that it has passed into common speech as one of those observations admitting no contradiction.

But to bring out prominently the contrast of these two worlds, they must be studied more in detail than we have thus far done; we must compare them, in order to deduce, by the comparison itself, the special character of each. This is what we are going to attempt. We have already seen that they differ in the forms of their relief and in their climate; we shall further see that these fundamental differences produce analogous effects in the organized beings, and in the entire physical life of each of the two worlds. Finally, we shall speak of the manner in which they act upon each other and seem, by their very nature, destined not to live isolated, but to form together a single organism, a grand harmony.

During the whole of this study, please to remember, gentlemen, that we are in the realm of nature, and not in that of history. The America we are seeking to understand is that which Columbus and his successors discovered, still entirely a virgin

* These Lectures were delivered by Prof. Guyot in French at the Lowell Institute, in January and February, 1849. The vigorous and eloquent thoughts of the author are well expressed in the elegant translation of Prof. Felton.

world, centuries ago; and not the New World of history, of which we shall have to speak later, that has come to plant itself on that soil.

A general comparison of the two groups of continents, will call to mind some of the leading features we have already become acquainted with, and add still others.

The Old World and the New World differ in the groupings, and in the number and extent of the continents composing them; in their astronomical situation, with respect to the climatic zones; in the general direction of their lands; in their interior structure. This assemblage of opposite characters secures to each of them a climate, a vegetation, and an animal kingdom, peculiarly their own.

I say first, in their groupings:—

The Old World is composed of four continents. Setting aside Australia, which is only an island in the midst of the oceanic hemisphere, it numbers three, all very near each other, aggregated and forming an oval compact mass, whose extent far surpasses that of every other terrestrial space. It presents a solid extent of land, the most vast, the most unbroken, the least accessible in its centre to the influences of the ocean. The Old World is preëminently the *continental* world.

The New World has only two continents, North America and South America, America and Columbia, as I should like to call them—to render justice where right belongs—if it were not forbidden to change names consecrated by long usage. These two continents are not grouped in one mass, nor placed side by side, but separated from each other, not touching upon their long sides, but by their exterior angles, standing in line, rather than grouped. They are situated in two opposite hemispheres, and thus more distant from each other, apparently, and less neighboring.

The result of this remarkable disposition is that narrow, lengthened, slender form we see in the New World. No portion of the interior is very remote from the sea-coasts; everywhere it gives access to the influences of the ocean, in the midst of which it is placed, like a long island. This form already contrasted with that of the Old World, gives to it its character. The New World is essentially *oceanic*.

The astronomical position, relatively to the climatic zone, is also not the same in the two worlds.

The Old World is, as it were, crowded back upon the north of the equator; it belongs for the most part, to the northern hemisphere and to the temperate zone. Of the three principal continents composing it, the two whose importance is by far the greatest, Europe and Asia, are temperate. Asia penetrates the torrid regions only by the southern peninsulas; Europe at no point; Australia is sub-tropical; Africa only is truly tropical. Even if

we take in the last two continents, more than two-thirds of the lands are situated in the temperate regions, one-third only in the equatorial regions. The Old World is then essentially *temperate.*

In the New World the lands are distributed in a manner nearly equal in the two zones and in the two hemispheres. We find that of the countries it includes, those which are the most richly endowed, are situated under the sun of the tropics. Compared with the Old World, the New World is thus essentially *tropical.*

The general direction of the lands, or the direction in which their length extends, is the inverse in the two worlds. The Old World has its greatest prolongation from east to west, in the line of the parallels; the New World from north to south, in the direction of the meridians. Both have a length of about 7,500 miles, but the breadth of the Old World is nearly double that of the New. This disposition is of the greater consequence for the distribution of the climates in each of them, since this configuration coincides, as we have seen, with the interior structure, with the direction of the principal mountain chains and of the table lands. From one end to the other of the Old World, over a space of several thousand miles, the migratory tribes are able to pursue their adventurous roaming course, by following, according to their custom, the great features of relief of the soil, without witnessing any change in the vegetation or the animals that surround them. They change place, but not climate, nor ways of life. This similarity of climates over long spaces is, then, a property of the Old World, and must have singularly favored the dispersion of the primitive tribes.

In the New World, on the contrary, the zones of similar climates are short and numerous; and if we travel over the whole length of the two Americas, we pass twice in succession through all the temperatures, from the frozen climate of the pole to that of the equator, and from the burning climate of the equator to that of the poles. This diversity of climate gives their character to the Americas.

Meantime, the interior structure modifies in the two worlds these climatic relations, in such a manner as to correct the uniformity of climate in the Old by more marked contrasts, and the too great diversity of the New, by gentler and better graduated transitions. We shall see this as we proceed to a closer examination of the structure of the two Americas, which will particularly occupy us this evening.

What characterizes the interior structure of the New World is its simplicity. In place of the variety of the Old World, where, in spite of a few general features common to both, each continent is, as it were, cast in a separate mould, the two Americas seem absolutely formed upon the same plan. This plan may be sketched out in a few lines. Two triangles, their vertices

turned to the south, one situated northwest of the other; the long cord of the Rocky Mountains and of the Andes, running the length of the extreme western coast, and binding the two continents together; great plains on the east, forming the larger part of their surface; a slight elevated chain along the Atlantic coast of both, the Alleghanies in North America, the Serra do Espinhaço and the Serra do Mar of Brazil, in South America; finally, in the centre, three short, transverse chains, that of Parime, in the Guyanas, that of Venezuela, and that of the great Antilles, broken into a number of islands;—these, in a few words, are all the essential features of this vast division of the world.

That which constitutes the richness of organization in the continents, is the number and abundance of internal contrasts calling out at once the activity of nature and that of man. The Old World is full of them; America has only a small number, all tending to disappear by reason of the structure itself.

Thus in Asia and Europe, the line of the highest lands, the continental axis, extending from the Himalaya to the Alps and the Pyrenees, divides these two continents into two unequal parts, one north and one south, opposite in climate, in vegetation, and even in races. Scarcely anywhere is the transition from one to the other gradual; almost everywhere it is abrupt and sudden. The table lands of Tubet and frigid Mongolia touch the tropical plains of China and of the Indies; the traveller who passes the Alps, abandons the severe landscapes and the firs of the North, to descend, by a single day's journey, into the ever verdant gardens and the orange groves of fair Italy; he exchanges the cold mists of the North for the sun of the South, and often leaves on one side, the snows and frosts of winter, to find on the other, the warm breath of spring, its verdure and its flowers.

This striking contrast between the North and the South reflected in the character and history of all the nations of Asia and Europe, is doubtless found in America; nowhere is it better known than in this country. But in nature it is almost effaced, it is softened down. It does not form a barrier; it nowhere presents an abrupt change; nowhere breaks the unity. On account of the continued plains of the continent, we see the natural character of the North gradually melt into that of the South. Between the shores of the Frozen Ocean and the Gulf of Mexico there lies the whole distance from the icy regions to the tropics. But it is only slowly, and over long spaces, that we pass through the transition. From the treeless polar plains, where flows the Mackenzie River, whose only covering is the mosses and the lichens, we pass only by degrees to the coniferous forests of Lake Superior; then to the oaklands of Wisconsin: the walnuts, hickories, and the chestnuts of Ohio and Kentucky next appear; farther south, the magnolia and the palmetto already

herald the air of the tropics and the neighborhood of the Gulf of Mexico. Two thousand four hundred miles separate the extremes of this scale of vegetation which almost touch each other in the Himalaya.

It is, moreover, to these vast plains, which offer no obstacles to the dissemination of the species, and to the absence of great chains from east to west, that we undoubtedly owe the appearance at the North, of plants and animals that seem to belong only to the tropical regions. It is not without surprise that the European landing on these shores sees the humming bird, that diamond of the tropics, glancing in the sun in a country which winter clothes, during long months, in a thick mantle of snow and ice.

It is the same towards the South, where we see the palm trees and the parrots of the tropics, here and there, as far as the Pampas of Buenos Ayres, much beyond their natural limits.

Thus the contrast between the North and the South is softened, reduced; but it is not annihilated; it exists on a great scale from one of the continents to the other: for North America is temperate, and South America is tropical.

America is cut by the Andes into two parts, east and west, as Asia and Europe are cut into two parts, north and south. But this contrast also is almost neutralized, as we shall soon understand.

The inequality is here carried to the extreme, to such a reduction of one of the parts, that it loses its importance, and, so to speak, its power of reaction. The western coast, dry and barren, has not extent and influence enough to enter upon an effective rivalry with the vast countries of the East. Moreover, the difficulty of communication renders the mutual action and the intercourse between the countries situated at the foot of the two inclinations, still more rare. Finally, the two sides of the Andes, being under the same latitudes, have the same, or nearly the same climate, and only differ in the degree of moisture or dryness falling to their portion. The West of the two Americas is only a narrow strip, not to be compared with the great plains of the East occupying nearly the entire continent, and giving it its character.

America is then less rich in internal contrasts than the Old World, but it has more of unity, because it is more simple. Undoubtedly in this uniformity of structure, in this absence of obstacles to a free circulation from end to end of this world, we are to look for one of the principal causes of that common character, of that American physiognomy which strikes us in all the organized beings of this continent, and which we find again in man himself, in the Indian, all the tribes of whom, from the banks of the Mackenzie River to Patagonia, have the same coppery tint and a family likeness in features, impossible to mistake.

The climate of the New World, compared with that of the Old, is distinguished by the abundance of pluvial waters, in general, by a greater humidity. We have seen in what manner this phenomenon is the consequence of its narrow and lengthened form; of the opening of the great plains—that is, of the two continents almost entire—to the winds of the sea; of the absence of high mountains in the East; in a word, of the configuration and general exposure of this part of the globe. While the Old World, with its compact figure, its vast plateaus, its high lands in the East, receives only an average of 77 inches of water by the year under the tropics, America receives 115 inches. The temperate regions of Europe have 34 inches; North America, 39 inches.

Add to this abundance of water, the extent of plains which permit the development of vast systems of water courses, and you will understand the existence of that innumerable multitude of rivers and lakes, which are one of the most characteristic features of the two Americas. Notwithstanding a much smaller extent than that of the Old World, the New possesses the largest rivers on the earth; the richest in waters, those whose basins occupy the vastest spaces. Where can we find, on the surface of the globe, a river equal to the mighty Marañon, that giant among the rivers of the earth, gathering its waters from a surface of a million and a half square miles, and bearing them to the ocean, after a course of 3,000 miles? This mighty monarch receives in his progress the homage of tributaries, each of which, by its greatness and the abundance of its waters, would suffice for the wants of a whole vast country. Such are the Ucayale, the Rio Purus, the Rio Negro, above all, the Madera, rivalling in importance the river to which it yields the honor of giving a name to their united waters. The farther it advances in its majestic course, the more its proportions increase; and before arriving at the ocean, its broad sheet, from the middle of which the eye cannot reach the banks, seems rather to be a fresh-water sea, flowing sluggishly towards the ocean basin, than a river of the continent. Far from its mouth, the fresh and muddy waters of the Amazon are still distinguished at a glance of the eye from the saline and limpid waters of the ocean; and their slime, borne along by their currents, goes to form, farther north, a new soil on the shores of the continent.

In the other continent, the Father of Waters, the mighty Mississippi, the second of the rivers of the earth, equals in length the Marañon itself; for its winding course is 3,000 miles. But its basin covers only from 8 to 900,000 square miles. Who does not know the importance of tributaries like the Missouri, which wrongly gives up its name for that of its less powerful brother; like the Ohio, the Beautiful River, the stream with transparent

waters; like the Arkansas, and so many others composing that vast system of arteries that vivify the whole West, and that are destined to assume daily a greater and greater importance? And these immense rivers are not isolated. At the side of the Marañon, the La Plata has a course of not less than 1,900 miles, and more than a million of square miles send it their waters. At the side of the Mississippi, the St. Lawrence has a course of 1,800 miles and a basin of nearly a million of square miles.

The Old World offers nothing similar. The greatest of its rivers, the Yan-tse-Kiang in China, has a course of only 2,500 miles. The Ganges and the Nile are far from equalling it. The Volga, the greatest of the rivers of Europe, exhibits a course of only 1,700 miles: and if it were necessary to enumerate in America rivers like the Rhine, so celebrated, it would be almost by hundreds that we should have to cite them.

And what shall we say of the abundance of its lakes? The group of the great lakes of Canada, so characteristic of North America, finds nowhere a parallel. It contains at once the largest lakes in the world, and the greatest mass of fresh water united on the surface of the continents. These vast seas of fresh water, together with the St. Lawrence, cover a surface of nearly 100,000 square miles, and it has been calculated that they contain almost one-half of all the fresh waters on the surface of our planet. They, too, are not alone, and a glance of the eye at the map, enables us to perceive in the North a multitude of lakes but little inferior in extent: the lake Athapescow, Winnipeg, Slave Lake, the Great Bear, are worthy to figure side by side with the lakes of Canada and of the St. Lawrence.

The rivers and the lakes are the wealth, and justly form the boast of America. No continent possesses so great a number, or those of so large extent, so well provided with water, so navigable. Not only do they fertilize the rich countries they traverse, but they are now, and will become still more so, the great highways of commerce between all the parts of this vast world; we already see enough to hope everything of the future.

Thus, gentlemen, the watery element reigns in the New World; add to this, that although half of its lands are exposed to the rays of the tropical sun, yet, all the conditions being equal, America is, on the whole, a little less warm than the Old World, and we shall have the essential features of its climate,—the oceanic climate. This is what America owes to the fundamental forms and the relative disposition of its lands; while the Old World is indebted to the preponderance of land for its dry and continental climate.

Let us now follow out the consequence of these physical circumstances upon the development of organic beings, and the character of the New World will come out in all its clearness.

The warm and the moist—these are the most favorable conditions for the production of an exuberant vegetation. Now, the vegetable covering is nowhere so general, the vegetation so predominant, as in the two Americas. Behold, under the same parallel where Africa presents only parched table lands, those boundless virgin forests of the basin of the Amazon, those selvas, almost unbroken over a length of more than 1,500 miles, forming the most gigantic wilderness of this kind that exists in any continent. And what vigor, what luxuriance of vegetation! The palm trees, with their slender forms, calling to mind that of America itself, boldly uplift their heads 150 or 200 feet above the ground, and domineer over all the other trees of these wilds, by their height, by their number, and by the majesty of their foliage. Innumerable shrubs and trees of smaller height fill up the space that separates their trunks; climbing plants, woody-stemmed climbing lianos, infinitely varied, surround them both with their flexible branches, display their own flowers upon the foliage, and combine them in a solid mass of vegetation, impenetrable to man, which the axe alone can break through with success. On the bosom of their peaceful waters swims the Victoria, the elegant rival of the Rafflesia, that odorous and gigantic water lily, whose white and rosy corolla, fifteen inches in diameter, rises with dazzling brilliancy from the midst of a train of immense leaves, softly spread upon the waves, a single one covering a space of six feet in width. The rivers rolling their tranquil waters under verdurous domes, in the bosom of these vast wilds, are the only paths that nature has opened to the scattered inhabitants of these rich solitudes. Elsewhere, in Mexico and Yucatan, an invading vegetation permits not even the works of man to exist; and the monuments of a civilization comparatively ancient, which the antiquary goes to investigate with care, are soon changed into a mountain of verdure, or demolished, stone after stone, by the plants piercing into their chinks, pushing aside with vigor, and breaking with irresistible force, all the obstacles that oppose their rapid growth.

South America, and particularly the basin of the Amazon, is the true kingdom of the palm trees; nowhere does this noble form of vegetation show itself under a greater number of species. This is a sign of the preponderating development of leaves over every other part of the vegetable growth; of that expansion of foliage, of that *leafiness*, which is peculiar to warm and moist climates. America has none of those plants with slender, shrunken leaves, like Africa and New Holland. The Ericas, or heather, so common, so varied, so characteristic of the flora of the Cape of Good Hope, is a form unknown to the New World. There is nothing which resembles those Metrosideri of Africa, those dry Myrtles (Eucalyptus) of New Holland, and willow-

leaved acacias, the flowers of which shine with the liveliest colors, but whose narrow foliage, turned edgewise to the vertical sun, casts no shadow. Everywhere, long and abundant leaves, an intense verdure, a strong and well-nurtured vegetation, these are what we find in tropical America.

North America, in spite of its more continental climate, shares no less in this character of the New World. The beauty and extent of the vast forests that cover its soil, the variety of the arborescent species composing them, the strong and lofty size of the trees which grow there, all these are too well known for me to stop to describe them. It is because this continent adds to a more abundant irrigation, a soil slightly mountainous, almost everywhere fertile, securing to it always an equal moisture, a more abundant harvest of all the vegetables useful to man.

Not only is the vegetation abundant in the New World, but it is universal, and this is a farther characteristic distinguishing it from the Old. We do not see there those vast deserts, so common in the other continents, and occupying a considerable portion of their surface. The Deserts of California and that of Atacama are exceptions, and, compared with those of Africa and Asia, scarcely seem made for anything except to serve as specimens. The llanos of Orinoco, which their geological nature dooms apparently to the fate of Sahara, are copiously watered during the rainy season, and are covered then with an admirable vegetation. Life, which seemed almost to slumber, almost extinguished, springs up again more beautiful and more vigorous. To the powdered sand swept along by the winds, succeed rich pastures, where range a multitude of indigenous animals, mingled with herds of horses, and wild asses, coming from Europe; and thousands of reptiles buried in the watery slime during the dry season, reappear, and fill again with life the temporary rivers and lakes with which these valleys are then overflowed. The pampas themselves are not without vegetation, and support at all times numerous herds. And who is ignorant that the vast prairies of the Mississippi and the Missouri produce every year an abundant vegetation, on which feed the bisons and the other wild tenants of the country.

But what becomes of the animal in the peculiar kingdom of vegetation? Blessings are shared; all treasures do not belong to one country alone. This luxuriant vegetation, it might be said, seems to stifle the higher life, in the animal world. Animal life is, as it were, overruled, enfeebled; it does not occupy here the first rank, which is its due; for that which favors it is dry heat, the continental element.

From one end to the other of the animal scale, the families that seem to give to these countries their character, by the number of their species and by their relative abundance, are those

which connect themselves, by their mode of life, with the aqueous, or with the vegetative element.

Hence, nothing is more splendid, more sparkling, than the insect world in South America. The inexhaustible variety of their species, the brilliancy of their colors, the size of their bodies, make them one of the most beautiful ornaments of these regions. Here live the Hercules beetle, the largest of the Coleoptera; and those brilliant butterflies with broad wings, the Menelaus, the Adonis, the Achilles, whose varying colors glitter in the sun like diamonds. But why be astonished? The existence of this little animal world is almost altogether dependent on the vegetation; the wealth of the one must create the wealth of the other.

Among the vertebrates, no family is so largely represented as that of the reptiles, for moisture is their element, and the rivers and temporary lagoons of the rainy season are peopled with Caimans, the crocodiles of the New World; the Iguanas, the most gigantic of the lizards; the Basilisks and other species, which multiply in the warm and still waters. The forests harbor in great numbers serpents of every form and figure, even to those monstrous boas, that are the terror of the natives themselves. They seem to be at home in this country.

But among the superior animals, development seems to be arrested; it is incomplete. The prevailing types are at the same time the inferior types. Among the birds, the stilt-plovers, inhabitants of the marshes and the shores, of which the number of species surpasses far, in America, that of any other continent. In the mammifera, the order of Edentata, the Armadillos, the Pangolins, the Ant-eaters, the Sloths, which characterize, more than any other family, the fauna of South America, not only in the present epoch, but also in the geological ages. And if we seek representatives of the higher orders, we find them less numerous in species, smaller in size; in a word, far inferior to the corresponding animals of the Old World. In the order of the Pachyderms, instead of the elephant, the rhinoceros, the hippopotamus, those giants of the Old World, the feeble and harmless tapir and the pecari. In the Ruminants, instead of the camel and the dromedary, the lama of the Andes, which reaches only half their size. Instead of the lordly lion of Africa, and the ferocious tiger of the islands of the Ganges, the Ounce and the Jaguar of the forests of Brazil, which are scarcely more than large cats. In the monkeys, finally, those with a prehensile tail, which are peculiar to America, are reckoned among the least perfect, the lowest of their order in the scale of organization.

Not only are the superior animals ill represented on this continent, but they have not the strength, nor the indomitable courage, not the ferocity, nor the intelligence of the similar creatures of the Old World. In all tropical America especially, as we see, the

whole animal kingdom remains in an inferior condition. It is subjected to the watery element, and to the vegetable world; for in those regions where vegetable life is the superior, animal life stands but in the second degree.

North America, however, in consequence of her more continental character, possesses some superior types, which recall to mind, and perhaps equal, those of the Old World. The majestic bison, the deer, the elk, and the bear, give evidence of that same vigorous northern nature which predominates in the temperate continents, and of which, as we shall see, North America possesses her share.

Man himself, the indigenous man I mean, bears in his whole character the ineffaceable stamp of this peculiarly vegetative nature. Living continually in the shadow of those virgin forests which overspread the earth that he inhabits, his whole nature has been modified thereby. The very copper hue of his complexion indicates that he lives not, like the negro, beneath the scorching sunbeams. His lymphatic temperament betrays the preponderance in his nature of the vegetative element. The Indian is of a melancholy, cold and insensible race. "Foreign to our hopes, our joys, our griefs," says a traveller, "it is rarely that a tear moistens his eyes, or that a smile lights up his features." The most barbarous tortures cannot extort from him a single complaint, and his stoical indifference is disturbed only by vengeance or jealousy. If he sometimes exhibits a display of prodigious muscular force, he is yet without endurance. Who knows not that when the first invaders of the New World endeavored to compel the inoffensive Indians, who had received them as gods, to the rude labors of the mines and the cultivation of the soil, these men of the woods, incapable of enduring fatigue, perished in agony by thousands? And it was thereupon that the Europeans substituted for the Indian the robust and vigorous native of the Old World, the negro, who, still to this day, used as the instruments of the white man's labor, endures, I had almost said, daily, a degree of toil equal to that which destroyed the native of the country.

The social condition of the Indian tribes is tinctured, in an equal degree, by the powerful influence of his vegetative character. The Indian has continued the man of the forest. He has seldom elevated himself above the condition of the hunter, the lowest grade in the scale of civilization. The exuberance of the soil has never been of value to him; for he asks not of the earth his nourishment. He has never even ascended to the rank of the pastoral man. With him no domestic animals are maintained to feed him with their milk, or clothe him with their fleeces, as they are by the nomadic races of the Old World. From one extremity of America to the other, we find the same lamentable spec-

tacle; the people of the elevated table lands of Mexico and Peru, are the only exception to this picture, and this exception goes far to establish the influence of the vegetative and humid nature of the lower plains of America. For if these nations do not exhibit the same character of inferiority, if they have raised themselves a little higher in the sphere of humanity, by the aid, perchance, of elements foreign to their own continent, it cannot be for other cause than that, living in those heights, those aërial islands, above the influence of the hot and humid atmosphere, they have been removed from the potency of its action.

Such, gentlemen, is the order, the admirable connection of the phenomena of nature with each other. The conformation and position of the New World give to it a hot and watery climate; this impresses its own character on all the organized creation. Man himself, the one being preëminently free, is liable to its influence, in proportion as he neglects the exertion of those superior faculties with which he is endowed for the conquest and subjugation of that nature which was intended, not to govern, but to serve him.

We may rest, then, in this conclusion, that, as compared with the Old World, the New World is the humid side of our planet, the *oceanic*, *vegetative* world, the passive element that awaits the excitement of a livelier impulse from without. Such is the America of Nature, such was it before the arrival of the man of the Old World. We know already, and we shall see better yet hereafter, all that his superior intelligence has been enabled to effect in the way of improving upon nature."

ART. XVI.—*On the relation of the Laws of Mechanics to Perpetual Motion;** by JEREMIAH DAY, late President of Yale College.

I CAN not engage to furnish any infallible remedy, for the mortifying disappointments which abound in this fascinating field of investigation; yet it may not be altogether a waste of time, to pay some little attention to a subject which has levied such heavy contributions, on the inventive faculties of modern mechanicians and philosophers. The hints which I propose to suggest will be principally on the *nature* of perpetual motion, the *benefits* to be expected from it, the *difficulties* to be encountered

* *Messrs. Editors*—If it be consistent with the purpose of your invaluable Journal, to admit upon its pages a paper which offers to the attention of the readers nothing original, no newly discovered principles of science, no improved combinations of machinery; the following plain thoughts on the application of the established laws of mechanics to the subject of *perpetual motion* are at your disposal.

Very respectfully, yours, &c.,

New Haven, July, 1850. J. DAY.

by the inventors, and the methods by which we may form an opinion whether it has been actually attained.

Perpetual motion is a motion continued without ceasing, and without any renewed application of force. A machine may be said to possess a principle of perpetual motion, if it continues to move, as long as it is kept in repair; and if it requires no new force to be applied to it from without. It is no part of the requisition concerning perpetual motion, that the machinery should never be out of repair. If it goes when it is in order, that is all that is demanded. What is looked for, is not perfection in the construction of the apparatus, but an unfailing moving force. On the other hand, it is required, that this force belong to the machine itself; that it be not an application from without. A stream of water may run continually. It may be applied to turn the wheel of a mill. It may in this way, become a never failing moving force. If the mill could be kept always in repair, the stream might be sufficient to turn it, as long as the world stands. But this is not what is meant by the perpetual motion of a machine, as the expression is commonly used. The moving force is here no part of the mill; it is applied from without. What is wanted is a principle of motion within the machine itself; or at least, so connected with it, as to accompany it wherever it may be removed.

It is farther expected that the moving force should require no new supply of *materials* to keep it in action. In the steam engine, the moving force is within the machine; and its agency may be continued without interruption. But a constant supply of fuel is necessary, to keep it in operation; and there is a continual demand for labor, to furnish the fuel. To save this expense of materials and labor, is the very purpose for which perpetual motion is wanted.

It is this which renders the proposed invention so highly important. Extravagant as the expectations of many ardent inventors may appear, there is reason to believe, that in this case, they would be more than realized, if the long sought for principle could once be laid hold of, and brought into general operation. It would be of no great use perhaps, to produce an instrument which would *merely go*, a wheel, for instance, which would revolve continually, without having force enough to result in any valuable product. A sawmill which would run of itself would be an object of curiosity; but would be of very little practical use, if the saw merely played up and down, without cutting the timber. The force which is necessary to put a machine in motion is generally much less, than that which is requisite to accomplish the object for which the machine is constructed. But there is reason to believe that if a perpetual moving force could once be discovered, it might be increased, to any desirable extent:

that if a power could be found which would continually overbalance the resistance of the air, and the friction of the parts of the apparatus, it might be so multiplied, as to produce any of the effects for which force is required in the arts. If for instance the moving principle were a weight, and ten pounds could be so applied as to preserve an uninterrupted motion of the machine, a hundred pounds would accomplish much more. As the weight might be easily enlarged, to almost any extent whatever, there would scarcely be any bounds to the effects to be produced. The vast expense now incurred, in providing reservoirs of water, in producing steam, in procuring labor, &c., as moving forces, might be wholly dispensed with. In the various manufacturing establishments, in this country, and in Europe, millions of dollars might be saved, in a single year. The invention might be considered a mine of wealth, even to a nation. It would not, perhaps, necessarily follow, that a power which would put in operation a *standing* machine, as a mill or manufacturing establishment, would be adapted to the *progressive* motion of a plow or a coach. But it would seem less difficult to make such an application of a moving force, than to originate the force itself. If this additional improvement could be effected, our oxen and our draft horses might be relieved from their labors; our carriages would be seen rolling through the streets of themselves; and we should be brought near to the state of perfectibility predicted by Godwin, when a plow need only to be let loose into a field, to accomplish the work of tillage.

Mankind have not been insensible to the immense advantages to be derived from perpetual motion. There is perhaps, no one subject on which the inventive faculties have more frequently been called into exercise. It is doubtful whether a single year, or even a single week has passed, for centuries, in which it has not occupied the earnest attention of some one. Many are probably employed in the search, who never disclose their attempts to the public. They have a double motive for keeping the secret; on the one hand, to secure to themselves the rewards of their success; on the other, to conceal their disappointment, in case of a failure. Persons of very various descriptions and occupations have been engaged in the pursuit. The man of science and the illiterate mechanic, have both eagerly contended for the prize, and generally with equal success.

It is natural to inquire, what can be the cause which has produced such universal failure, where the zeal for attaining the object has been so ardent, and so long continued. What are the difficulties which, with so provoking a pertinacity, unceasingly throw themselves in the way of the sanguine inventor? It would be in vain to attempt to enumerate *all* the obstacles which a subject so fruitful in disappointments presents. They will vary ac-

cording to the means which are used to effect the object, and according to the characters of the different projectors. The man of science will be liable to embarrassments of one kind; the mere mechanician, to those of another. The chief impediments in the way of the man of science are certain *general principles*, denominated laws of nature. His ingenuity is exercised in endeavoring to evade these; but they obstinately meet him at every turn; and in spite of all his windings, he finds himself brought back to the same ground from which he started.

Nothing but what is capable of producing *motion*, can be the cause of *perpetual* motion. The moving forces which are commonly applied to machines are weights, springs, running water, steam, wind, and the strength of animals. Of these, water, wind, and animal strength can not produce what is commonly meant by perpetual motion, because they are not constituent parts of the machine. They are forces applied from without. But steam, springs, and weights may belong to the machine itself. Of these, the weight of a heavy body is that which is generally made use of, to produce perpetual motion. A weight is a very simple moving force, and may be made very powerful. The only difficulty with respect to it is, that it produces its effect only by *descending;* and that when it reaches the ground, its operation ceases. If it could be made to descend and then ascend, with the same force, it might keep a machine in perpetual action.

The difficulty is not, as some seem to have supposed, that a weight can move a body in one direction only. It can produce motion in *any* direction; not indeed by mere pressure, but by the aid of some very simple apparatus, for instance, a cord passing over a pulley. Nothing is easier than to change the direction in which a given power is to act upon the object to be moved. A weight may make a body either ascend, or descend, or move horizontally. But the real difficulty is, that the power will not move at all, after it has reached the ground. Its operation then ceases entirely. The great thing wanted is not a change in the direction, but a *continuance* of the motion.

Neither does the obstacle to perpetual motion consist in the law, that matter is incapable of originating motion in itself, or of effecting any *change* in its own motions. The difficulty lies not in *beginning* the motion, but in rendering it perpetual. The labor and expense of merely putting a machine in operation would be of no account, if the movement would only continue. Now the first law of motion, instead of obstructing the continuance of the action, is the very principle on which that continuance depends, unless there is a renewed application of external force. There is one known instance of actual perpetual motion,

the revolution of the heavenly bodies. This is owing to the fact, that they are incapable of putting a stop to their own motion, and that there is nothing else to stop them. But if matter were endowed, like animals, with a principle of voluntary motion, it would be as easy for it to cease to move, at pleasure, as to begin to move. It would then be as difficult to produce perpetual motion in a machine, as in a horse or an elephant.

Some of the principles which really stand in the way of the inventors of perpetual motion are the following.

1. In every machine, there is some *loss* of motion, from friction and the resistance of the air; and commonly a much greater loss, from the expenditure of force, in producing the effect for which the machine is designed. When a certain momentum is given to a body, it will continue the same, till there is some cause to vary it. A wheel suspended freely on an axis would revolve with a uniform velocity, if friction and the resistance of the air could be entirely removed. Perpetual motion would then be a thing of course. But these obstructions it is impossible to avoid; and they necessarily occasion a continual loss of motion.

In addition to this, a machine, to answer any practical purpose, must not only *go*, but it must also be capable of a constant expenditure of force upon the effect to be produced. A slitting mill, for instance, must not only be kept in motion, but must furnish a continual supply of force, to separate the iron. The loss of motion on this account is far greater than that occasioned by friction and resistance of the air. Both must be compensated by a renewal of force from some quarter or other. It is the aim of the inventor of perpetual motion, so to arrange his apparatus, that this new supply shall be furnished from the machine itself; that it shall not be dependent on any application from without. But in attempting to accomplish this object, he finds himself under the necessity of encountering a second unaccommodating principle.

2. Every body which communicates motion to another, loses an equal portion of its own motion. In other words, action and reaction are equal. It follows from this, that no portion of matter can communicate to another portion a greater momentum than it possesses itself. If that part of a machine in which the moving force begins to act could produce, in another part, a motion greater than its own, we might obtain a *multiplication* of force; and in this way, we might secure a surplus, to supply the deficiency occasioned by friction, &c. But after all the trials which have been made upon bodies in every conceivable variety of condition, they obstinately refuse to communicate what they do not themselves possess. On this fact is founded a third important principle.

3. *No combination of machinery* produces any real increase of force. This is the fact with respect to each of the instruments called mechanical powers taken singly; and it is equally true, in whatever way they may be combined with each other. The use of all apparatus of this kind is not to create force, nor to increase it, but merely to apply it. It is true, indeed, that a mechanical power may be so contrived, that a small weight may raise a very great one. But it will raise it a very short distance only. If one is a thousand times as large as the other, the latter must descend a thousand feet to raise the former one foot. So that the *momentum* of the large body is no greater than that of the smaller one. There is, therefore, no increase of force obtained.

One or two cautions are necessary, however, in estimating the velocities of the power and the weight. In the first place, the velocity is to be reckoned *in that direction* in which the moving force of the body acts. Thus if a body moves down an *inclined plane*, the moving force is gravitation, which acts towards the center of the earth. The velocity, when we are calculating the equilibrium, must be estimated in this direction. In the second place, there must be brought into the account, *that part* only of the power which is concerned in producing the effect. If a weight act *obliquely* on the arm of a lever, a part of its force will be lost. This must be thrown out of the estimate.

With these qualifications, we shall find, that however complicated may be the apparatus, the power will be to the weight in equilibrio, as the velocity of the weight to the velocity of the power. As their momenta are equal, there is no increase of force produced by the machinery. This is a proposition, however, which one who is in pursuit of perpetual motion can not be brought fully to believe, till he has learned it by mortifying experience. He expects, by some peculiar arrangement of his levers, and wheels, and inclined planes, to make it appear that this is only a *theoretical* maxim, intended to answer the purposes of speculative philosophy. He seeks after modes of combination which may vary, as much as possible, from those already in use, that he may fall upon the grand secret, in some mysterious disposition of parts, which has hitherto escaped observation. But the effect of all this is commonly to *diminish* the power which he wishes to increase. For although, according to the received laws of mechanics, no combination of machinery will create force; yet it is very easy, by an unskillful arrangement, to destroy motion.

After all, the projector finds an unfailing source of motion in the *weight* of a heavy body. Though he may acknowledge, perhaps, that machinery will not of itself produce force, yet he considers that *gravitation* is a power which is perpetually operating, and that, if he can only arrange his apparatus so as to catch

this force, and apply it to his use, he has all that he wants. He here finds a very important exception to the general law, that a body is incapable of putting itself in motion. Matter has a continual and powerful tendency to move towards the earth. A body needs only to be left to itself, to descend with a force proportioned to its weight. But he is driven even from this refuge, by a fourth general principle.

4. A body, *by its weight*, communicates motion in no other way than by *descending;* and when it has once reached the earth, its operation ceases, till it is raised up again, with a force equal to that with which it descended. This does not mean that a body can, *in no case*, communicate motion except by descending itself. A heavy body moving in *any* direction may impel another in the same direction. A cannon ball may drive before it the object which it strikes. This is not done, however, by the weight of the ball, but by the momentum which it has received from a foreign force. What we are now considering is the motion produced by the *gravity* of the body, not that which is occasioned by the application of mechanical force from without. Neither does the principle just stated imply, that a body may not, *by its weight*, cause *another* body to move in any direction except towards the earth. The weight in one scale of a balance may cause those in the other side to rise. But to do this it must itself descend. Nor in the third place, is it to be understood, that a body can not by its weight, have an effect of *any* kind without descending. It may, even in a state of rest, have great influence in *preventing* motion. It may be a powerful *resisting* force, but it is not then a moving force. In preserving the equilibrium of bodies *at rest*, very great advantage may be derived from the application of the instruments called mechanical powers. By means of a lever or an inclined plane, one pound may be made to balance a thousand. Archimedes might have held a world in equilibrio. But the moment the lever is put in motion, the comparative importance of the smaller body is lost. What is gained in weight is lost in velocity.

With these explanations, we may consider the principle as universal, that no body produces motion by its weight, except by descending. If, for instance, a heavy body is laid upon an inclined plane, this plane may move horizontally. But unless the *weight* descends, the motion of the plane is owing to some other cause than the pressure of this weight.

Now the great difficulty in making the gravity of a body a source of perpetual motion is: that the body must soon reach the ground, that in descending it acquires only a certain degree of momentum, that it can communicate no greater momentum to the machine, and that, in order to repeat the operation, there must be a force at least equal to this, to bring it back to the height

from which it has descended. There is, therefore, no force at all derived from the weight, except during the period of a single descent, and that only equal to the power which had been applied to raise it up to the point of starting. It will be said, perhaps, that the weight may be made to restore itself, that it may acquire a velocity in falling, sufficient to raise it to the same height again. So it may. The ball of a pendulum may raise itself to the same point from which it started, or nearly so. But it can do nothing more. The force acquired in the descent will be all expended in the ascent. There will be nothing left to be applied to any machinery.

There is no avoiding of this result, unless some way can be contrived to make the body either acquire a greater force by falling, or expend less in rising. No method has yet been devised, to bring a body to the ground by its weight, with a greater force than that which it acquires by falling *perpendicularly.* It may be made to roll down an inclined plane, to descend on the arc of a circle, on the arm of a lever, or along a series of lines differently inclined to the horizon. But in every such case, though it is easy to *diminish* the force of the descent; yet there is no way of *increasing* it, but by the application of a foreign impulse. On the other hand, a body can, by no device, be raised up to its original height, but by a power equivalent to that which it acquires in descending. There is, according to the received laws of mechanics, no way in which it may be brought back again, with a less expenditure of force than that which is necessary to raise it up *perpendicularly.* It may be carried round in such a manner as to employ a *greater* power; but nothing *less* than this will be sufficient to restore it.

But may not advantage be taken of some of the *mechanical powers,* to effect the object with more economy of force. Suppose the weight be made to *descend* on the longer arm of a lever, and to *ascend* on the shorter arm. If one be twice as long as the other, may not one pound raise nearly two pounds? It may. But it will raise them only half as far as it moves itself, so that nothing is gained by *this* expedient. Such is the uniform result of the projector's devices to bring up his weight with a less force than that which it acquires in falling perpendicularly. Like the stone of Sisyphus, in spite of all his efforts, it is forever rolling back upon him.

We shall be brought to the same conclusion, by another view of the subject. No body of machinery has any tendency to move by its weight, any longer than this motion will cause the *center of gravity* to descend. This is a principle of very convenient application, because it brings us at once to the result. We are under no necessity of inquiring into the peculiar *structure* of the machine. Whatever be the arrangement of the parts, as soon as

the center of gravity of the whole has reached the lowest point, the motion will cease, except that it may continue a while, from the momentum already acquired.

We may, upon this principle, easily perceive the defect of those numerous perpendicular *wheels*, which have been formed with cavities in the radii or other parts, so as to contain fluids or balls rolling alternately to and from the center. The object here is to have the weights near the *axis*, while they are ascending, and near the *periphery* when descending, so as to act upon the principle of the wheel and axis. The fallacy is the same here, as in the longer and shorter arms of the lever. But to detect this, there is no necessity of examining the particular structure. Whatever be the disposition of the parts, when the center of gravity of the wheel and its contents has reached the lowest point, the tendency to move, from the weight, is at an end. The defect of the contrivance is also evident from the consideration, that as the wheel revolves, each of the balls must rise to a *certain height*, and it is immaterial by what *route* it arrives there, whether by going round on the periphery, or taking a shorter course near the axis.

Similar difficulties will be presented, if instead of the weight of a *solid* body, we substitute the pressure of a *fluid*. According to what is called the hydrostatic paradox, a pound of water may balance and set in motion a quantity ever so great. But the motion will not, perhaps, be more than a thousandth part of an inch, before the effect will cease.

After dwelling so long upon the weight, as a moving force, it will not be necessary to enter into a particular consideration of the action of *springs*. The difficulty, in the two cases, is nearly the same. A spring which is coiled up, as in a watch, produces its effect by expanding. When it is unbent, its action ceases till it is wound up again; and to wind it up requires a force equal to that with which it expands. There is, therefore, no balance left, for the purposes of machinery.

In the case of *steam*, the continuance of the motion is to be sought for, not upon mechanical, but upon chemical principles. Here perhaps there is more reason to hope, because the ground has not been so long and so thoroughly explored. But it is not improbable, that the balance of *affinities* in chemistry, will prove to be as untractable, as the balance of momenta in mechanics. A similar remark may be applicable to the imponderable agents, electricity, galvanism, and magnetism.

Some of the difficulties which lie in the way of the *man of science*, in his pursuit after perpetual motion, have now been stated. But perhaps this is not the class of persons which are most likely to succeed, in this field of investigation. The invention, if it should ever be made, may proceed from some one who

has little or no knowledge of the laws of mechanics. The philosopher commences the inquiry with ardor; but soon stumbles upon one of his unyielding general principles, and then abandons the pursuit as hopeless. The uninformed mechanic is not so easily disheartened. If he fails in one attempt, he sees no reason why he should not succeed in the next. Perseverance supplies the want of skill. His very *blunders* may turn to his advantage, by leading to combinations of machinery which a person of more scientific views would have rejected without trial. *He* however is not exempt from embarrassments. They are mostly of a nature not to be particularly described. But they all terminate in one; his machine *won't go.*

It must be acknowledged, however, that although this is the general result, it is not universal. There is, here and there, a solitary exception. A man, after years of thought, and toil, and disappointment, finds at length the object of all his wishes attained. His machine goes. His labors are at an end. His fortune and his fame are secured. He has shown himself superior to all the pretenders to science and mechanical skill. His name is to go down to posterity, in the same rank with Bacon and Newton. But in the intoxication of success, one thing seems to have escaped him. He has forgotten that all *motion* is not *perpetual* motion. His machine stops. His dream is ended; and he awakes to the realities of the life of a sober mechanic.

Must we then be driven to the conclusion, that perpetual motion is absolutely and forever impossible? Shall we obstinately close our eyes and ears against all proof which may be offered of its actual existence? Shall we reject the testimony of our senses, when we see the machine really in motion? When a man professes to have made the great discovery, and calls upon us to accede to his pretensions, we have a right to suspend our opinion, till he has made good his claim, either by shewing the *principle* on which it depends, or by furnishing the proof by *actual trial.* If a new principle is advanced, in opposition to those hitherto received, we may safely admit it, when it has stood the test of as thorough an investigation as they have. The established laws of mechanics have been the subject of strict examination for centuries; they have been turned in almost every conceivable point of view, for the very purpose of eliciting from them perpetual motion; they have been scrutinized by the profoundest mathematicians, and the most skillful experimenters; they have been put to the trial, in a thousand different forms of machinery. Almost every mechanical instrument now in use exhibits experimental proof of their soundness. When any *new* principle can plead as much in its favor, it may fairly be put in competition with the old ones.

But the inventor, though he may not boast of *theory* on his side, has that which is of far greater importance, the support of *fact*. His machine *goes*. So does a time piece go. It may be made to go, for a whole year together, without being wound up. But this is not *perpetual* motion. In a clock, a force is wanted to supply the loss from friction. If the instrument is nicely constructed, this loss may be very small. A large weight may furnish the requisite supply, for a long time, without coming to the ground. But when it has descended as far as it can, its power is exhausted, and the motion ceases. To determine from trial whether any particular machine has an unfailing principle of action, we must wait till the force first applied has had time to spend itself. If we are impatient to come to a more speedy decision, there is a way in which the point may be soon settled. The apparatus may be so well adjusted, that it may take weeks or months, perhaps, to exhaust the moving force, in merely overcoming the friction. But let it be required to do something more. Instead of merely going, let it be applied to some practical purpose. Let it be employed, for instance, in the grinding of grain, or the sawing of timber. In proportion as the resistance is increased, the time of its action will be shortened, if, like other machines, it is dependent on a renewed application of force from without. But if it possesses a perpetuating principle, this may be made to supply that part of the loss of momentum which proceeds from the resistance of the grain or the timber; as well as that which is owing to friction and the air. In this manner, the instrument may be brought to the test of experiment, in a very short time.

With respect to any supposed invention, in years past, of an instrument for perpetual motion; we have only to inquire, whether it is now in operation, in our manufacturing establishments of every description; whether our mills, and forges, our steamboats, and our railroad cars are actually moved by it. An improvement which is to produce so complete a revolution in practical mechanics, could not long be concealed, or confined to the inventor. It would be coveted and circulated, as eagerly as a bank of guineas. A man professes to have discovered an inexhaustible treasure. He has unfolded a secret, which thousands have sought for in vain. He has opened a mine of gold, which is accessible to every one. Its value is beyond all computation. And yet, strange to tell, it lies neglected and forgotten, neither wrought by himself, nor by any one else.

ART. XVII.—*Contributions to the Mycology of North America;* by Rev. M. J. BERKELEY, of England, and Rev. M. A. CURTIS, of South Carolina.

101. POLYPORUS RHIPIDIUS, Berk.—Ad truncos putridos. Sept. —Ohio (Lea); Santee Canal, S. C. (Ravenel.)

102. P. VALENZUELIANUS, Mont.—Ad truncos emortuos. Santee Canal;—Ravenel.

103. P. EPILEUCUS, Fr.—Ad truncos Pini. Autumno. Society Hill and Santee Canal.

104. P. RIGIDUS, Berk.—Ad lignum cariosum. Hieme. Mr. Ravenel.

105. P. (Anodermei) FISSILES, Berk. and Curt.;—albus; pileo dimidiato vertice elongato rugoso hic illic aculeato-setoso; intus fibroso-fissili insigniter zonato; poris mediis subrotundis acie obtusiuscula.—Autumno. On old stumps. Society Hill, S. Car.

Cap 6 in. broad, 2 long, or, with the vertex, 3½, undulated, with numerous raised lines which are sparingly aculeato-setose; substance splitting into fibres, zoned throughout; pores about $\frac{1}{5}$ in. broad.—A fine species belonging to the same section as P. *spumeus*, remarkable for its strongly zoned highly fibrous substance; allied to *P. borealis*, but with larger pores, firmer dissepiments, and a more fibrous texture.

106. P. SENEX, Mont.—Ad truncum. Autumno. Santee Canal, Mr. Ravenel.

107. P. VELLEREUS, Berk.—Oregon. U. S. Exploring Expedition.

108. P. LINDBLADII, Berk.—Ad truncos dejectos. Autumno. Ravenel.

109. P. LACERATUS, Berk.—Ad truncos emortuos præsertim Quercuum. Hieme. Vere. N. and S. Car.

110. P. FLORIDANUS, Berk.—Ad truncos emortuos Myricæ, &c. Hieme. Ravenel.

111. P. ARCTICUS, Klotsch.—Ad truncos emortuos. Autumno. Hieme. N. and S. Car. et N. York. Dr. Sartwell.

112. P. (Inodermei) CHARTACEUS, Berk. and Curt.;—rigido-membranaceous ambiens e resupinato utrinque reflexus; pileo leviter zonato albido sericeo; poris sistotrematoideis pallidis. Subter ram. et trunc. dejectis Liriodendri. Vere. Hillsborough, N. Car.

Effused for several feet and completely surrounding the smaller branches, broadly reflexed; margin membranaceous but rigid; pores about $\frac{1}{5}$ in. broad, breaking into obtuse lamellar processes, extending to the margin where they are shallow and more dis-

tant.—Allied to *P. pinsitus*, of which we at first thought it was a variety, but differing in its nearly smooth pileus and the singularly decomposed pores.

113. P. NIGER, Berk.—Ad trunc. Querc. deject. cariosum. Hieme. S. Car. (Ravenel.) Ohio, (Lea.)

114. P. CREMOR, Berk. and Curt.; resupinatus albus; margine obsoleto, poris parvis subrotundis, dissepimentis crassis, acie obtusissima.—Ad ram. querc. dejectos. Vere. Society Hill.

Allied to *P. vulgaris*, but differing in its thick dissepiments and the obtuse edge of the pores.

115. P. SALMONICOLOR, Berk. and Curt.;—resupinatus crassus, mycelio mucedineo albo, poris rotundis rubellis demum elongatis purpureo-fuscis.—Ad lignum pineum adustum. Aestate. Santee Canal. Ravenel.

Effused, several inches broad, margin thin, centre thick, of a rich salmon color, at length brown. Pores small, at length torn and angular. When fresh this appears to be very tender and easily injured, in which state it becomes dark purple brown, with a resinous aspect. Not closely allied to any described species. Its nearest affinities are with *P. purpureus*, Fr. and *P. rhodellus*, Fr., or better with *P. carneofuscus*, P.

116. DAEDALEA CINEREA, Fr.—Ad trunc. dejectum. Autumno. R. Island; Mr. Bennett.

117. D. SÆPIUM, Berk.—Ad lignum Quercûs, Taxodii, &c. Autumno. Hieme. Ohio (Lea), R. Island (Mr. Bennett), N. and S. Carolina.

118. LENZITES CRATÆGI, Berk.—Ad Liquidambar. Society Hill, S. C.

119. FAVOLUS CURTIPES, Berk. and Curt.;—pileo tenui reniformi carnoso-rigido glabro; stipite brevissimo disciformi; poris mediis sinuatis plicatis.—Ad trunc. mort. Autumno. Ravenel.

Cap 2 in. broad, 1½ long, very smooth, rigid, and tawny when dry. Pores $\frac{1}{36}$ in. broad, pale, undulated and crisped; edge white. An extremely pretty species resembling *F. cucullatus*, Mont.; but the pores are less rigid and smaller, the substance more fleshy.

120. GLŒOPORUS CONCHOIDES, Mont.—Ad trunc. prostratum. Society Hill, S. Car.

121. MERULIUS CORIUM, Fr.—Ad cort. Quercûs, Castaneæ, &c. Autumno, Vere. S. Car.

122. M. INCRASSATUS, Berk. and Curt.;—effusus resupinatus, crassus margine breviter reflexo; plicis poriformibus.—Ad lign. pineum cariosum. Society Hill, S. Car.

Effused for several inches, resupinate, with the margin shortly reflexed, dirty white and slightly silky. Substance thick, fleshy. Folds forming small brownish pores. Allied to *M. tremellosus*.

123. Porothelium Friesii, Mont.—Ad corticem Juniperi. Hieme. Santee Canal; Ravenel.

ARRHYTIDIA, nov. gen.—Hymenophorum a mycelio mucedineo contexto formatum, marginatum, tectum hymenio ceraceo molli lævi sine plicis. Sporæ oblongæ.

124. Arrhytidia flava, Berk. and Curt.—Ad ramos dejectos Pini. Society Hill, S. Car.

Forming little scattered, sometimes confluent patches, ⅓ in. broad, consisting of a white mycelium which forms a distinct border to the smooth orange yellow hymenium; sometimes the border is double. Spores oblong, fixed obliquely at the base.

This has just the habit of *Psilopezia*, but is without *Asci*. It is a distinctly bordered, mostly pezizæform *Merulius*, destitute of folds.

125. Hydnum velutinum, Fr.—Ad terram in sylvis. Hillsborough, N. Car.

126. H. graveolens, Delastre.—Ad basin caudicum in sylvis. Aestate. Society Hill, S. Car.

127. H. pulcherrimum, Berk. and Curt.;—dimidiatum crassum lobatum spongiosum carnoso-fibrosum hirsùtum intus zonatum, margine tenui; aculeis breviusculis subulatis. Ad truncos prostratos in paludosis. Aestate, Autumno. Santee Canal, (Mr. Ravenel,) and Society Hill, S. Car.

Pilei very white becoming pale tawny, subimbricated, 3–6 in. broad, 2–3 long, 1–2 thick, of a soft spongy consistence, clothed with copious stiff down which is more or less matted with age, sometimes as if gummed together. Substance slightly zoned. Teeth 1–2 lines long, tawny.—This splendid species is closely allied to *H. septentrionale*, but is smaller, far less imbricated, and clothed with much stiffer hairs. The generai texture is precisely that of *Pol. hispidus*.

128. H. pithyophilum, Berk. and Curt.;—resupinatum effusum, subiculo tenuissimo farinaceo-byssoideo; aculeis ochraceis compressis apice dentato-laceris.—Ad ram. dejectos (lign. et cort.) pineos, Autumno, Hieme. Society Hill, S. C.

Forming confluent patches several inches in length. Subiculum extremely thin, sometimes farinaceous, sometimes finely byssoid, white. Teeth pale ochraceous 1 line long, more or less toothed or jagged at the apex.—Resembling resupinate states of *H. ochraceum*, but differing both in the subiculum and teeth.

129. H. ciliolatum, Berk. and Curt.;—resupinatum orbiculare tenue vix a matrice solubile; aculeis brevibus compressis floccoso-ciliolatis.—Ad ramos dejectos (lign. et cort.) Quercus et Liriodendri (?). Autumno. Society Hill.

Forming small orbicular patches, an inch or two in diameter, nearly white with a pale ochraceous tint, thin, margin minutely byssoid, sometimes slightly raised. Teeth short, minutely ciliated with fine flocci, extending to the very margin where they are merely little downy fascicles.—Resembling resupinate forms of *H. ochraceum*, but differing widely in the nature of the teeth.

130. H. PLUMOSUM, Duby.—In rimis cort. crassæ Pini. Hieme. Society Hill.

ART. XVIII.—*Experimental Researches in Electricity.—Twenty-third Series;* by MICHAEL FARADAY, Esq., D.C.L., F.R.S., etc.*

§ 29. *On the polar or other condition of diamagnetic bodies.*

2640. FOUR years ago I suggested that all the phenomena presented by diamagnetic bodies, when subjected to the forces in the magnetic field, might be accounted for by assuming that they then possessed a polarity the same in kind as, but the reverse in direction of, that acquired by iron, nickel and ordinary magnetic bodies under the same circumstances (2429. 2430.). This view was received so favorably by Plücker, Reich and others, and above all by W. Weber,† that I had great hopes it would be confirmed; and though certain experiments of my own (2497.) did not increase that hope, still my desire and expectation were in that direction.

2641. Whether bismuth, copper, phosphorus, &c., when in the magnetic field, are polar or not, is however an exceedingly important question; and very essential and great differences in the mode of action of these bodies under the one view or the other, must be conceived to exist. I found that in every endeavor to proceed by induction of experiment from that which is known in this department of science to the unknown, so much uncertainty, hesitation and discomfort arose from the unsettled state of my mind on this point, that I determined, if possible, to arrive at some experimental proof either one way or the other. This was the more needful, because of the conclusion in the affirmative to which Weber had come in his very philosophical paper; and so important do I think it for the progress of science, that in those imperfectly developed regions of knowledge, which form its boundaries, our conclusions and deductions should not go far beyond, or at all events not aside from the results of experiment (except as suppositions), that I do not hesitate to lay my present labors, though they arrive at a negative result, before the Royal Society.

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* From the Trans. Roy. Soc., London, Part I, for 1850.—Read March 7 and 14, 1850.

† Poggendorff's Annalen, January 7, 1848, or Taylor's Scientific Memoirs, v, p. 477.

2642. It appeared to me that many of the results which had been supposed to indicate a polar condition, were only consequences of the law that diamagnetic bodies tend to go from stronger to weaker places of action (2418.); others again appeared to have their origin in induced currents (26. 2338.); and further consideration seemed to indicate that the differences between these modes of action and that of a real polarity, whether magnetic or diamagnetic, might serve as a foundation on which to base a mode of investigation, and also to construct an apparatus that might give useful conclusions and results in respect of this inquiry. For, if the polarity exists it must be in the particles and for the time permanent, and therefore distinguishable from the momentary polarity of the mass due to induced temporary currents; and it must also be distinguishable from ordinary magnetic polarity by its contrary direction.

2643. A straight wooden lever, 2 feet in length, was fixed by an axis at one end, and by means of a crank and wheel made to vibrate in a horizontal plane, so that its free extremity passed to and fro through about 2 inches. Cylinders or cores of metal or other substances, 5½ inches long and three-quarters of an inch diameter, were fixed in succession to the end of a brass rod 2 feet long, which itself was attached at the other end to the moving extremity of the lever, so that the cylinders could be moved to and fro in the direction of their length through the space of 2 inches. A large cylinder electro-magnet was also prepared (2191.), the iron core of which was 21 inches long and 1·7 inch in diameter; but one end of this core was made smaller for the length of 1 inch, being in that part only 1 inch in diameter.

2644. On to this reduced part was fixed a hollow helix consisting of 516 feet of fine covered copper wire: it was 3 inches long, 2 inches external diameter, and 1 inch internal diameter: when in its place, 1 inch of the central space was occupied by the reduced end of the electro-magnet core which carried it; and the magnet and helix were both placed concentric with the metal cylinder above mentioned, and at such a distance that the latter, in its motion, would move within the helix in the direction of its axis, approaching to and receding from the electro-magnet in rapid or slow succession. The least and greatest distances of the moving cylinder from the magnet during the journey were one-eighth of an inch and 2·2 inches. The object of course was to observe any influence upon the experimental helix of fine wire which the metal cylinders might exert, either whilst moving to or from the magnet, or at different distances from it.*

* It is very probable that if the metals were made into cylinders, shorter but of larger diameter than those described above, and used with a corresponding wider helix, better results than those I have obtained would be acquired.

2645. The extremities of the experimental helix wire were connected with a very delicate galvanometer, placed 18 or 20 feet from the machine, so as to be unaffected directly by the electro-magnet; but a commutator was interposed between them. This commutator was moved by the wooden lever (2643.), and as the electric currents which would arrive at it from the experimental helix, in a complete cycle of motion or to and fro action of the metal cylinder (2643.), would consist of two contrary portions, so the office of this commutator was, sometimes to take up these portions in succession and send them on in one consistent current to the galvanometer, and at other times to oppose them and to neutralize their result; and therefore it was made adjustible, so as to change at any period of the time or part of the motion.

2646. With such an arrangement as this, it is known that, however powerful the magnet, and however delicate the other parts of the apparatus, no effect will be produced at the galvanometer as long as the magnet does not change in force, or in its action upon neighboring bodies, or in its distance from, or relation to, the experimental helix; but the introduction of a piece of iron into the helix, or anything else that can influence or be influenced by the magnet, can, or ought to, show a corresponding influence upon the helix and galvanometer. My apparatus I should imagine, indeed, to be almost the same in principle and practice as that of M. Weber (2640.), except that it gives me contrary results.

2647. But to obtain correct conclusions, it is most essential that extreme precaution should be taken in relation to many points which at first may seem unimportant. All parts of the apparatus should have perfect steadiness, and be fixed almost with the care due to an astronomical instrument; for any motion of any portion of it, is, from the construction, sure to synchronize with the motion of the commutator; and portions of effect, inconceivably small, are then gathered up and made manifest as a whole at the galvanometer; and thus, without care, errors might be taken for real and correct results. Therefore, in my arrangements, the machine (2643, &c.), the magnet and helix, and the galvanometer stood upon separate tables, and these again upon a stone floor laid upon the earth; and the table carrying the machine was carefully strutted to neighboring stone-work.

2648. Again, the apparatus should itself be perfectly firm and without shake in its motion, and yet easy and free. No iron should be employed in any of the moving parts. I have springs to receive and convert a portion of the momentum of the whole at the end of the to and fro journey; but it is essential that these should be of hammered brass or copper.

2649. It is absolutely necessary that the cylinder or core in its motion should not in the least degree disturb or shake the exper-

imental helix and the magnet. Such a shake may easily take place, and yet (without much experience) not be perceived. It is important to have the cores of such bodies as bismuth, phosphorus, copper, &c., as large as may be, but I have not found it safe to have less than one-eighth of an inch of space between them and the interior of the experimental helix. In order to float, as it were, the core in the air, it is convenient to suspend it in the bight or turn of a fine copper wire passing once round it, the ends of which rise up, and are made fast to two fixed points at equal heights but wide apart, so that the wire has a V form. This suspension keeps the core parallel to itself in every part of its motion.

2650. The magnet, when excited, is urged by an electric current from five pairs of Grove's plates, and is then very powerful. When the battery is not connected with it, it still remains a magnet of feeble power, and when thus employed may be referred to as in the *residual state.* If employed in the residual state, its power may for the time be considered constant, and the experimental helix may at any moment be connected with the galvanometer without any current appearing there. But if the magnet be employed in the excited state, certain important precautions are necessary; for upon connecting the magnet with the battery and then connecting the experimental helix with the galvanometer, a current will appear at the latter, which will, in certain cases, continue for a minute or more, and which has the appearance of being derived at once from that of the battery. It is not so produced, however, but is due to the *time* occupied by the iron core in attaining its maximum magnetic condition (2170. 2332.), during the whole of which it continues to act upon the experimental helix, producing a current in it. This time varies with several circumstances, and in the same electro-magnet varies especially with the period during which the magnet has been out of use. When first employed, after two or three days' rest, it will amount to eighty or ninety seconds, or more. On breaking battery contact and immediately renewing it, the effect will be repeated, but occupy only twenty or thirty seconds. On a third intermission and renewal of the current, it will appear for a still shorter period; and when the magnet has been used at short intervals for some time, it seems capable of receiving its maximum power almost at once. In every experiment it is necessary to wait until the effect is shown by the galvanometer to be over; otherwise the last remains of such an effect might be mistaken for a result of polarity, or some peculiar action of the bismuth or other body under investigation.

2651. The galvanometer employed was made by Ruhmkorff and was very sensible. The needles were strengthened in their action and rendered so nearly equal, that a single vibration to the

right or the left occupied from sixteen to twenty seconds. When experimenting with such bodies as bismuth or phosphorus, the place of the needle was observed through a lens. The perfect communication in all parts of the circuit was continually ascertained by a feeble thermo-electric pair, warmed by the fingers. This was done also for every position of the commutator, where the film of oxyd formed on any part by two or three days' rest was quite sufficient to intercept a feeble current.

2652. In order to bring the phenomena afforded by magnetic and diamagnetic bodies into direct relation, I have not so much noted the currents produced in the experimental helix, as the effects obtained at the galvanometer. It is to be understood, that the standard of deviation, as to direction, has always been that produced by an iron wire moving in the same direction at the experimental helix, and with the same condition of the commutator and connecting wires, as the piece of bismuth or other body whose effects were to be observed and compared.

2653. A thin glass tube, of the given size (2643.), $5\frac{1}{2}$ by $\frac{3}{4}$ inches, was filled with a saturated solution of protosulphate of iron, and employed as the experimental core: the velocity given to the machine at this and all average times of experiment was such as to cause five or six approaches and withdrawals of the core in one second; yet the solution produced no sensible indication at the galvanometer. A piece of magnetic glass tube (2354.), and a core of foolscap paper, magnetic between the poles of the electro-magnet, were equally inefficient. A tube filled with small crystals of protosulphate of iron caused the needle to move about 2°, and cores formed out of single large crystals, or symmetric groups of crystals of sulphate of iron, produced the same effect. Red oxyd of iron (colcothar) produced the least possible effect. Iron scales and metallic iron (the latter as a thin wire) produced large effects.

2654. Whenever the needle moved, it was consistent in its direction with the effect of a magnetic body; but in many cases, with known magnetic bodies, the motion was little or none. This proves that such an arrangement is by no means so good a test of magnetic polarity as the use of a simple or an astatic needle. This deficiency of power in that respect does not interfere with its ability to search into the nature of the phenomena that appear in the experiments of Weber, Reich and others.

2655. Other metals than iron were now employed and with perfect success. If they were magnetic, as nickel and cobalt, the deflection was in the same direction as for iron. When the metals were diamagnetic, the deflection was in the contrary direction; and for some of the metals, as copper, silver and gold, it amounted to 60° or 70°, which was permanently sustained as long as

the machine continued to work. But the deflection was not the greatest for the most diamagnetic substances, as bismuth, or antimony, or phosphorus; on the contrary, I have not been able to assure myself, up to this time, that these three bodies can produce any effect. Thus far the effect has been proportionate to the *conducting power* of the substance for electricity. Gold, silver and copper have produced large deflections, lead and tin less. Platina very little. Bismuth and antimony none.

2656. Hence there was every reason to believe that the effects were produced by the currents induced in the mass of the moving metals, and not by any polarity of their particles. I proceeded therefore to test this idea by different conditions of the cores and the apparatus.

2657. In the first place, if produced by induced currents, the great proportion of these would exist in the part of the core near to the dominant magnet, and but little in the more distant parts; whereas in a substance like iron, the polarity which the whole assumes makes length a more important element. I therefore shortened the core of copper from 5½ inches (2643.) to 2 inches, and found the effect not sensibly diminished; even when 1 inch long it was little less than before. On the contrary, when a fine iron wire, 5½ inches in length, was used as core, its effects were strong; when the length was reduced to 2 inches, they were greatly diminished; and again, with a length of 1 inch, still further greatly reduced. It is not difficult to construct a core of copper, with a fine iron wire in its axis, so that when above a certain length it should produce the effects of iron, and beneath that length the effects of copper.

2658. In the next place, if the effect were produced by induced currents in the mass (2642.), division of the mass would stop these currents and so alter the effect; whereas if produced by a true diamagnetic polarity, division of the mass would not affect the polarity seriously, or in its essential nature (2430.). Some copper filings were therefore digested for a few days in dilute sulphuric acid to remove any adhering iron, then well washed and dried, and afterwards warmed and stirred in the air, until it was seen by the orange color that a very thin film of oxyd had formed upon them: they were finally introduced into a glass tube (2653.) and employed as a core. It produced no effect whatever, but was now as inactive as bismuth.

2659. The copper may however be divided so as either to interfere with the assumed currents or not, at pleasure. Fine copper wire was cut up into lengths of 5½ inches, and as many of these associated together as would form a compact cylinder three-quarters of an inch in diameter (2643.); it produced no effect at the galvanometer. Another copper core was prepared by associating together many discs of thin copper plate, three-quarters of

an inch in diameter, and this affected the galvanometer, holding its needle 25° or 30° from zero.

2660. I made a solid helix cylinder, three-quarters of an inch in diameter and 2 inches long, of covered copper wire, one-sixteenth of an inch thick, and employed this as the experimental core. When the two ends of its wire were unconnected, there was no effect upon the experimental helix, and consequently none at the galvanometer; but when the ends were soldered together, the needle was well affected. In the first condition, the currents, which tended to be formed in the mass of moving metal, could not exist because the metal circuit was interrupted; in the second they could, because the circuit was not interrupted; and such division as remained did not interfere to prevent the currents.

2661. The same results were obtained with other metals. A core cylinder of gold, made of half-sovereigns, was very powerful in its effect on the galvanometer. A cylinder of silver, made of sixpenny pieces, was very effectual; but a cylinder made of precipitated silver, pressed into a glass tube as closely as possible, gave no indications of action whatever. The same results were obtained with disc cylinders of tin and lead, the effects being proportionate to the condition of tin and lead as bad conductors. (2655.)

2662. When iron was divided, the effects were exactly the reverse in kind. It was necessary to use a much coarser galvanometer and apparatus for the purpose; but that being done, the employment of a solid iron core, and of another of the same size or weight formed of lengths of fine iron wire (2659.), showed that the division had occasioned no inferiority in the latter. The excellent experimental researches of Dove* on the electricity of induction, will show that this ought to be the case.

2663. Hence the result of division in the diamagnetic metals is altogether of a nature to confirm the conclusion, that the effects produced by them are due to induced currents moving through their masses, and not to any polarity correspondent in its general nature (though opposed in its direction) to that of iron.

2664. In the third place (2656.), another and very important distinction in the actions of a diamagnetic metal may be experimentally established according as they may be due either to a true polarity, or merely to the presence of temporary induced currents; and as for the consideration of this point diamagnetic and magnetic polarity are the same, the point may best be considered, at present, in relation to iron.

2665. If a core of any kind be advanced towards the dominant magnet and withdrawn from it by a motion of uniform velocity, then a complete journey or *to* and *from* action might be

* Taylor's Scientific Memoirs, v. p. 129. I do not see a date to the paper.

divided into four parts; the *to*, the *stop* after it; the *from*, and the *stop* succeeding that. If a core of iron make this journey, its end towards the dominant magnet becomes a pole, rising in force until at the nearest distance, and falling in force until at the greatest distance. Both this effect and its *progression* inwards and outwards, cause currents to be induced in the surrounding helix, and these currents are in one direction as the core advances, and in the contrary direction as it recedes. In reality, however, the iron does not travel with a constant velocity; for, because of the communication of motion from a revolving crank at the machine (2643.), it, in the *to* part of the journey, gradually rises from a state of rest to a maximum velocity, which is half-way, and then as gradually sinks to rest again near the magnet:—and the *from* part of the journey undergoes the same variations. Now as the maximum effect upon the surrounding experimental helix depends upon the velocity conjointly with the intensity of the magnetic force in the end of the core, it is evident that it will not occur with the maximum velocity, which is in the middle of the *to* or *from* motion; nor at the *stop* nearest to the dominant magnet, where the core end has greatest magnetic force, but somewhere between the two. Nevertheless, during the *whole* of the advance, the core will cause a current in the experimental helix in one direction, and during the whole of the recession it will cause a current in the other direction.

2666. If diamagnetic bodies, under the influence of the dominant magnet, assume also a polar state, the difference between them and iron being only that the poles of like names or forces are changed in place (2429. 2430.), then the same kind of action as that described for iron would occur with them; the only difference being, that the two currents produced would be in the reverse direction to those produced by iron.

2667. If a commutator, therefore, were to be arranged to gather up these currents, either in the one case or the other, and send them on to the galvanometer in one consistent current, it should change at the moments of the two *stops* (2665.), and then would perform such duty perfectly. If, on the other hand, the commutator should change at the times of maximum velocity or maximum intensity, or at two other times equidistant either from the one *stop* or from the other, then the parts of the opposite currents intercepted between the changes would exactly neutralize each other, and no final current would be sent on to the galvanometer.

2668. Now the action of the iron is, by experiment, of this nature. If an iron wire be simply introduced or taken out of the experimental helix with different conditions of the commutator, the results are exactly those which have been stated. If the machine be worked with an iron wire core, the commutator changing at the stops (2665.), then the current gathered up and sent

on to the galvanometer is a maximum; if the commutator change at the moments of maximum velocity, or at any other pair of moments equidistant from the one stop or the other, then the current at the commutator is a minimum, or 0.

2669. There are two or three precautions which are necessary to the production of a pure result of this kind. In the first place, the iron ought to be soft and not previously in a magnetic state. In the next, an effect of the following kind has to be guarded against. If the iron core be away from the dominant magnet at the beginning of an experiment, then, on working the machine, the galvanometer will be seen to move in one direction for a few moments, and afterwards, notwithstanding the continued action of the machine, will return and gradually take up its place at 0°. If the iron core be at its shortest distance from the dominant magnet at the beginning of the experiment, then the galvanometer needle will move in the contrary direction to that which it took before, but will again settle at 0°. These effects are due to the circumstance, that, when the iron is away from the dominant magnet, it is not in so strong a magnetic state, and when at the nearest to it is in a stronger state, than the *mean* or *average state*, which it acquires during the continuance of an experiment; and that in rising or falling to this average state, it produces two currents in contrary directions, which are made manifest in the experiments described. These existing only for the first moments, do, in their effects at the galvanometer, then appear, producing a vibration which gradually passes away.

2670. One other precaution I ought to specify. Unless the commutator changes accurately at the given points of the journey, a little effect is gathered up at each change, and may give a permanent deflection of the needle in one direction or the other. The tongues of my commutator, being at right angles to the direction of motion and somewhat flexible, dragged a little in the *to* and *from* parts of the journey: in doing this they approximated, though only in a small degree, to that which is the best condition of the commutator for gathering up (and not opposing) the currents; and a deflection to the right or left appeared (2677.). Upon discovering the cause and stiffening the tongues so as to prevent their flexure, the effect disappeared, and the iron was perfectly inactive.

2671. Such therefore are the results with an iron core, and such would be the effects with a copper or bismuth core if they acted by a diamagnetic polarity. Let us now consider what the consequences would be if a copper or bismuth core were to act by currents, induced for the time, in its moving mass, and of the nature of those suspected (2642.). If the copper cylinder moved with uniform velocity (2665.), then currents would exist in it, parallel to its circumference, during the whole time of its motion;

and these would be at their maximum force just before and just after the *to* or inner stop, for then the copper would be in the most intense parts of the magnetic field. The rising current of the copper core for the *in* portion of the journey would produce a current in one direction in the experimental helix, the stopping of the copper and consequent falling of its current would produce in the experimental helix a current contrary to the former; the first instant of motion *outwards* in the core would produce a maximum current in it contrary to its former current, and producing in the experimental helix its inductive result, being a current the same as the last there produced; and then, as the core retreated, its current would fall, and in so doing and by its final stop, would produce a fourth current in the experimental helix, in the same direction as the first.

2672. The four currents produced in the experimental helix alternate by twos, *i. e.* those produced by the falling of the first current in the core and the rising of the second and contrary current, are in one direction. They occur at the instant before and after the stop at the magnet, *i. e.* from the moment of maximum current (in the core) before, to the moment of maximum current after, the stop; and if that stop is momentary, they exist only for that moment, and should during that brief time be gathered up by the commutator. Those produced in the experimental helix during the falling of the second current in the core and the rising of a third current (identical with the first) in the return of the core to the magnet, are also the same in direction, and continue from the beginning of the retreat to the end of the advance (or from maximum to maximum) of the core currents, *i. e.* for almost the whole of the core journey; and these, by its change at the maximum moments, the commutator should take up and send on to the galvanometer.

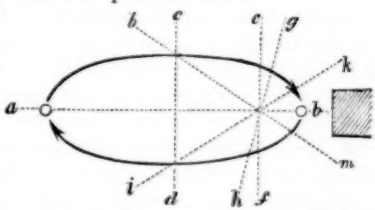
2673. The motion however of the core is not uniform in velocity, and so, sudden in its change of direction, but, as before said (2665.), is at a maximum as respects velocity in the middle of its approach to and retreat from the dominant magnet; and hence a very important advantage. For its stop may be said to commence immediately after the occurrence of the maximum velocity; and if the lines of magnetic force were equal in position and power there to what they are nearer to the magnet, the contrary currents in the experimental helix would commence at those points of the journey; but, as the core is entering into a more intense part of the field, the current in it still rises though the velocity diminishes, and the consequence is, that the maximum current in it neither occurs at the place of greatest velocity, nor of greatest force, but at a point between the two. This is true both as regards the approach and the recession of the core, the two maxima of the currents occurring at points equidistant from the place of rest near the dominant magnet.

2674. It is therefore at these two points that the commutator should change, if adjusted to produce the greatest effect at the galvanometer by the currents excited in the experimental helix, through the influence of, or in connection with, currents of induction produced in the core; and experiment fully justifies this conclusion. If the length of the journey from the stop out to the stop in, which is 2 inches (2643. 2644.), be divided in 100 parts, and the dominant magnet be supposed to be on the right hand, then such an expression as the following, 50|50, may represent the place where the commutator changes, which in this illustration would be midway in the to and from motion, or at the places of greatest velocity.

2675. Upon trial of various adjustments of the commutator, I have found that from 77|23 to 88|12, gave the best result with a copper core. On the whole, and after many experiments, I conclude that with the given strength of electro-magnet, distance of the experimental core when at the nearest from the magnet, length of the whole journey, and average velocity of the machine, 86|14 may represent the points where the induced currents in the core are at a maximum and where the commutator ought to change.

2676. From what has been said before (2667.), it will be seen that both in theory and experiment these are the points in which the effect of any polarity, magnetic or diamagnetic, would be absolutely nothing. Hence the power of submitting by this machine metals and other bodies to experiment, and of eliminating the effects of magnetic polarity, of diamagnetic polarity, and of inductive action, the one from the others: for either by the commutator or by the direction of the polarity, they can be separated; and further, they can also be combined in various ways for the purpose of elucidating their joint and separate action.

2677. For let the arrows in the diagram represent the to and from journey, and the intersections of the lines, *a*, *b*, or *c*, *d*, &c., the periods in the journey when the commutator changes (in which case *c*, *d* will correspond to 50|50, and *e*, *f* to 86|14), then *a*, *b* will represent the condition of the commutator for the maximum effect of iron or any other polar body. If the line *a*, *b*, be gradually revolved until parallel to *c*, *d*, it will in every position indicate points of commutator change, which will give the iron effect at the galvanometer by a deflection of the needle always in the same direction; it is only when the ends *a* and *b* have passed the points *c* and *d*, either above or below, that the direction of the deflection will change



for iron. But the line *a*, *b* indicates those points for the commutator with which no effect will be produced on the galvanometer by the induction of *currents* in the mass of the core. If the line be inclined in one direction, as *i*, *k*, then these currents will produce a deflection at the galvanometer on one side; if it be inclined in the other direction, as *l*, *m*, then the deflection will be on the other side. Therefore the effects of these induced currents may be either combined with, or opposed to, the effects of a polarity, whether it be magnetic or diamagnetic.

2678. All the metals before mentioned (2655.), namely, gold, silver, copper, tin, lead, platina, antimony and bismuth, were submitted to the power of the electro-magnet under the best adjustment (2675.) of the commutator. The effects were stronger than before, being now at a maximum, but in the same order; as regarded antimony and bismuth, they were very small, amounting to not more than half a degree, and may very probably have been due to a remainder of irregular action in some part of the apparatus. All the experiments with the divided cores (2658, &c.) were repeated with the same results as before. Phosphorus, sulphur and gutta percha did not, either in this or in the former state of the commutator, give any indication of effect at the galvanometer.

2679. As an illustration of the manner in which this position of the commutator caused a separation of the effects of copper and iron, I had prepared a copper cylinder core 2 inches in length having an iron wire in its axis, and this being employed in the apparatus gave the pure effect of the copper with its induced currents. Yet this core, as a whole, was highly magnetic to an ordinary test-needle; and when the two changes of the commutator were not equidistant from the one stop or the other (2670. 2677.), the iron effect came out powerfully, overruling the former and producing very strong contrary deflections at the needle. The platinum core which I have used is an imperfect cylinder, 2 inches long and 0·62 of an inch thick: it points magnetically between the poles of a horseshoe electro-magnet (2381.), making a vibration in less than a second, but with the above condition of the commutator (2675.) gives 4° of deflection due to the induced currents the magnetic effect being annulled or thrown out.

2680. Some of the combined effects produced by oblique position of the commutator points were worked out in confirmation of the former conclusions (2677.). When the commutator was so adjusted as to combine any polar power which the bismuth, as a diamagnetic body, might possess, with any conducting power which would permit the formation of currents by induction in its mass (2676.), still the effects were so minute and uncertain as to oblige me to say that, experimentally, it is without either polar or inductive action.

2681. There is another distinction which may usefully be established between the effects of a true sustainable polarity, either magnetic or diamagnetic, and those of the transient induced currents dependent upon *time*. If we consider the resistance in the circuit, which includes the experimental helix and the galvanometer coil, as nothing, then a magnetic pole of constant strength passed a certain distance into the helix, would produce the same amount of current electricity in it, whether the pole were moved into its place by a quick or slow motion. Or if the iron core be used (2668.) the same result is produced, provided, in any alternating action, the core is left long enough at the extremities of its journey to acquire, either in its quick or slow alternation, the same state. This I found to be the fact when no commutator nor dominant magnet was used; a single insertion of a weak magnetic pole gave the same deflection, whether introduced quickly or slowly; and when the residual dominant magnet, an iron wire core, and the commutator in its position, *a*, *b* were (2677.) used, four journeys to and from produced the *same* effect at the galvanometer when the velocities were as 1 : 5 or even as 1 : 10.

2682. When a copper, silver, or gold core is employed in place of the iron, the effect is very different. There is no reason to doubt, that as regards the core itself the same amount of electricity is thrown into the form of induced circulating currents within it, by a journey to or from, whether that journey is performed quickly or slowly: the above experiment (2681.) in fact confirms such a conclusion. But the effect which is produced upon the experimental helix is not proportionate to the whole amount of these currents, but to the maximum intensities to which they rise. When the core moves slowly, this intensity is small; when it moves rapidly, it is great, and necessarily so, for the same current of electricity has to travel in the two differing periods of time occupied by the journeys. Hence the quickly moving core should produce a far higher effect on the experimental helix than the slowly moving core: and this also I found to be the fact.

2683. The short copper core was adjusted to the apparatus, and the machine worked with its average velocity until forty journeys to and from had been completed; the galvanometer needle passed 39° west. Then the machine was worked with a greater rapidity, also for forty journeys, and the needle passed through 80° or more west; finally, being worked at a slow rate for the same number of journeys, the needle went through only 21° west. The extreme velocities in this experiment were probably as 1 : 6; the time in the longest case was considerably less than that of one vibration of the needle (2651.), so that I believe all the force in the slowest case was collected. The needle is very little influenced by the swing or momentum of its parts, because

of the deadening effect of the copper plate beneath it, and, except to return to zero, moves very little after the motion of the apparatus ceases. A silver core produced the same results.

2684. These effects of induced currents have a relation to the phenomena of revulsion which I formerly described (2310. 2315. 2338.), being the same in their exciting cause and principles of action, and so the two sets of phenomena confirm and illustrate each other. That the revulsive phenomena are produced by induced currents, has been shown before (2327. 2329. 2336. 2339.); the only difference is, that with them the induced currents were produced by exalting the force of a magnet placed at a fixed distance from the affected metal; whilst in the present phenomena, the force of the magnet does not change, but its distance from the piece of metal does.

2685. So also the same circumstances which affect the phenomena here affect the revulsive phenomena. A plate of metal will, as a whole, be well-revulsed; but if it be divided across the course of the induced currents it is not then affected (2529.). A ring helix of copper wire, if the extremities be unconnected, will not exhibit the phenomena, but if they be connected then it presents them (2660.).

2686. On the whole, the revulsive phenomena are a far better test and indication of these currents than the present effects; especially if advantage be taken of the division of the mass into plates, so as to be analogous, or rather superior, in their action to the disc cylinder cores (2659. 2661.). Platinum, palladium and lead in leaf or foil, if cut or folded into squares half an inch in the side, and then packed regularly together, will show the phenomena of revulsion very well; and that according to the direction of the leaves, and not of the external form. Gold, silver, tin and copper have the revulsive effects thus greatly exalted. Antimony, as I have already shown, exhibits the effect well (2514. 2519.). Both it and bismuth can be made to give evidence of the induced currents produced in them when they are used in thin plates, either single or associated, although, to avoid the influence of the diamagnetic force, a little attention is required to the moments of making and breaking contact between the voltaic battery and the electro-magnet.

2687. Copper, when thus divided into plates, had its revulsive phenomena raised to a degree that I had not before observed. A piece of copper foil was annealed and tarnished by heat, and then folded up into a small square block, half an inch in the side and a quarter of an inch thick, containing seventy-two folds of the metal. This block was suspended by a silk film as before (2248.), and whilst at an angle of 30° or thereabouts with the equatorial line (2252.), the electro-magnet was excited; it immediately advanced or turned until the angle was about 45° or 50°, and then

stood still. Upon the interruption of the electric current at the magnet the revulsion came on very strongly, and the block turned back again, passed the equatorial line, and proceeded on until it formed an angle of 50° or 60° on the other side; but instead of continuing to revolve in that direction as before (2315.), it then returned on its course, again passed the equatorial line, and almost reached the axial position before it stood still. In fact, as a mass, it vibrated to and fro about the equatorial line.

2688. This however is a simple result of the principles of action formerly developed (2329. 2336.). The revulsion is due to the production of induced currents in the suspended mass during the falling of the magnetism of the electro-magnet; and the effect of the action is to bring the axis of these induced currents parallel to the axis of force in the magnetic field. Consequently, if the time of the fall of magnetic force, and therefore of the currents dependent thereon, be greater than the time occupied by the revulsion of the copper block as far as the equatorial line, any further motion of it by momentum will be counteracted by a contrary force; and if this force be strong enough the block will return. The conducting power of the copper and its division into laminæ, tend to set up these currents very readily and with extra power; and the very power which they possess tends to make the time of a vibration so short, that two or even three vibrations can occur before the force of the electro-magnet has ceased to fall any further. The effect of *time*, both in the rising and falling of power, has been referred to on many former occasions (2170. 2650.), and is very beautifully seen here.

2689. Returning to the subject of the assumed polarity of bismuth, I may and ought to refer to an experiment made by Reich, and described by Weber,* which, if I understand the instruction aright, is as follows: a strong horseshoe magnet is laid upon a table in such a position that the line joining its two poles is perpendicular to the magnetic meridian and to be considered as prolonged on one side; in that line, and near the magnet, is to be placed a small powerful magnetic needle, suspended by cocoon silk, and on the other side of it, the pole of a bar magnet, in such a position and so near, as exactly to counteract the effect of the horseshoe magnet, and leave the needle to point exactly as if both magnets were away. Then a mass of bismuth being placed between the poles of the horseshoe magnet is said to react upon the small magnet needle, causing its deflection in a particular direction, and this is supposed to indicate the polarity of the bismuth under the circumstances, as it has no such action when the magnets are away. A piece of iron in place of the bismuth produces the contrary deflection of the needle.

* Taylor's Scientific Memoirs, v, p. 480.

2690. I have repeated this experiment most anxiously and carefully, but have never obtained the slightest trace of action with the bismuth. I have obtained action with the iron; but in those cases the action was far less than if the iron were applied outside between the horseshoe magnet and the needle, or to the needle alone, the magnets being entirely away. On using a garnet, or a weak magnetic substance of any kind, I cannot find that the arrangement is at all comparable for readiness of indication or delicacy, with the use of a common or an astatic needle, and therefore I do not understand how it could become a test of the polarity of bismuth when these fail to show it. Still I may have made some mistake; but neither by close reference to the description, nor to the principles of polar action, can I discover where.

2691. There is an experiment which Plücker described to me, and which at first seems to indicate strongly the polarity of bismuth. If a bar of bismuth (or phosphorus) be suspended horizontally between the poles of the electro-magnet, it will go to the equatorial position with a certain force, passing, as I have said, from stronger to weaker places of action (2267.). If a bar of iron of the same size be fixed in the equatorial position a little below the plane in which the diamagnetic bar is moving, the latter will proceed to the equatorial position with much greater force than before, and this is considered as due to the circumstance, that, on the side where the iron has N polarity, the diamagnetic body has S polarity, and that on the other side the S polarity of the iron and the N polarity of the bismuth also coincide.

2692. It is however very evident that the lines of magnetic force have been altered sufficiently in their intensity of direction, by the presence of the iron, to account fully for the increased effect. For, consider the bar as just leaving the axial position and going to the equatorial position; at the moment of starting its extremities are in places of stronger magnetic force than before, for it cannot be doubted for a moment that the iron bar determines more force from pole to pole of the electro-magnet than if it were away. On the other hand, when it has attained the equatorial position, the extremities are under a much weaker magnetic force than they were subject to in the *same places* before; for the iron bar determines downwards upon itself much of that force, which, when it is not there, exists in the plane occupied by the bismuth. Hence, in passing through 90°, the diamagnetic is urged by a much greater difference of intensity of force when the iron is present than when it is away; and hence, probably, the whole additional result. The effect is like many others which I have referred to in magnecrystallic action (2487–2497.), and does not, I think, add anything to the experimental proof of diamagnetic polarity.

2693. Finally, I am obliged to say that I can find no experimental evidence to support the hypothetical view of diamagnetic polarity (2640.), either in my own experiments, or in the repetition of those of Weber, Reich, or others. I do not say that such a polarity does not exist; and I should think it possible that Weber, by far more delicate apparatus than mine, had obtained a trace of it, were it not that then also he would have certainly met with the far more powerful effects produced by copper, gold, silver, and the better conducting diamagnetics. If bismuth should be found to give any effect, it must be checked and distinguished by reference to the position of the commutator, division of the mass by pulverization, influence of time, &c. It appears to me also, that, as the magnetic polarity conferred by iron or nickel in very small quantity, and in unfavorable states, is far more readily indicated by its effect on an astatic needle, or by pointing between the poles of a strong horseshoe magnet, than by any such arrangement as mine or Weber's or Reich's, so diamagnetic polarity would be much more easily distinguished in the same way, and that no indication of that polarity has as yet reached to the force and value of those already given by Brugmann and myself.

2694. So, at present, the actions represented or typified by iron, by copper and by bismuth, remain distinct; and their relations are only in part made known to us. It cannot be doubted that a larger and simpler law of action than any we are yet acquainted with, will hereafter be discovered, which shall include all these actions at once; and the beauty of Weber's suggestion in this respect was the chief inducement to me to endeavor to establish it.

2695. Though from the considerations above expressed (2693.) I had little hopes of any useful results, yet I thought it right to submit certain magnecrystallic cores to the action of the apparatus. One core was a large group of symmetrically disposed crystals of bismuth (2457.); another a very large crystal of red ferroprussiate of potassa; a third a crystal of calcareous spar; and a fourth and fifth large crystals of protosulphate of iron. These were formed into cylinders of which the first and fourth had the magnecrystallic axes (2479.) parallel to the axis of the cylinder, and the second, third and fifth, had the equatorial direction of force (2594. 2595. 2546.) parallel to the axis of the cylinder. None of them gave any effect at the galvanometer, except the fourth and fifth, and these were alike in their results, and were dependent for them on their ordinary magnetic property.

2696. Some of the expressions I have used may seem to imply, that, when employing the copper and other cores, I imagine that currents are first induced in them by the dominant magnet, and that these induce the currents which are observed in the ex-

perimental helix. Whether the cores act directly on the experimental helix or indirectly through their influence on the dominant magnet, is a very interesting question, and I have found it difficult to select expressions, though I wished to do so, which should not in some degree prejudge that question. It seems to me probable, that the cores act indirectly on the helix, and that their immediate action is altogether directed towards the dominant magnet, which, whether they consist of magnetic or diamagnetic metals, raises them into power either permanently or transiently, and has their power for that time directed towards it. Before the core moves to approach the magnet, the magnet and experimental helix are in close relation; and the latter is situated in the intense field of magnetic force which belongs to the pole of the former. If the core be iron, as it approaches the magnet it causes a strong convergence and concentration of the lines of magnetic force upon itself; and these, as they so converge, passing through the helix and across its convolutions, are competent to produce the currents in it which are obtained (2653. 2668.). As the iron retreats these lines of force diverge, and again crossing the line of the wire in the helix in a contrary direction to their former course, produce a contrary current. It does not seem necessary, in viewing the action of the iron core, to suppose any direct action of it on the helix, or any other action than this which it exerts upon the lines of force of the magnet. In such a case its action upon the helix would be indirect.

2697. Then, by all parity of reasoning, when a copper core enters the helix its action upon it should be indirect also. For the currents which are produced in it are caused by the direct influence of the magnet, and must react equivalently upon it. This they do, and because of their direction and known action, they will cause the lines of force of the magnet to diverge. As the core diminishes in its velocity of motion, or comes to rest, the currents in it will cease, and then the lines of force will converge; and this divergence and convergence, or passage in two directions across the wire of the experimental helix, is sufficient to produce the two currents which are obtained in the advance of the core towards the dominant magnet (2671. 2673.). A corresponding effect in the contrary direction is produced by the retreat of the core.

2698. On the idea that the actions of the core were not of this kind, but more directly upon the helix, I interposed substances between the core and the helix during the times of the experiment. A thick copper cylinder 2·2 inches long, 0·7 of an inch external diameter, and 0·1 of an inch internal diameter, and consequently 0·3 of an inch thick in the sides, was placed in the experimental helix, and an iron wire core (2668.) used in the apparatus. Still, whatever the form of the experiment, the kind and

amount of effect produced were the same as if the copper were away, and either glass or air in its place. When the dominant magnet was removed and the wire core made a magnet, the same results were produced.

2699. Another copper lining, being a cylinder 2·5 inches long, 1 inch in external diameter, and one-eighth of an inch in thickness, was placed in the experimental helix, and cores of silver and copper five-eighths of an inch in thickness, employed as before, with the best condition of the commutator (2675.): the effects, with and without the copper, or with and without the glass, were absolutely the same (2698.).

2700. There can be no doubt that the copper linings, when in place, were full of currents at the time of action, and that when away no such currents would exist in the air or glass replacing them. There is also full reason to admit, that the divergence and convergence of the magnetic lines of force supposed above (2697.) would satisfactorily account for such currents in them, supposing the indirect action of the cores were assumed. If that supposition be rejected, then it seems to me that the whole of the bodies present, the magnet, the helix, the core, the copper lining, or the air or glass which replaces it, must all be in a state of tension, each part acting on every other part, being in what I have occasionally elsewhere imagined as the electro-tonic state (1729.).

2701. The advance of the copper makes the lines of magnetic force diverge, or, so to say, drives them before it (2697.). No doubt there is a reaction upon the advancing copper, and the production of currents in it in such a direction as makes them competent, if continued, to continue the divergence. But it does not seem logical to say, that the currents which the lines of force cause in the copper, are the cause of the divergence of the lines of force. It seems to me, rather, that the lines of force are, so to say, diverged, or bent outward by the advancing copper (or by a connected wire moving across lines of force in any other form of the experiments), and that the reaction of the lines of force upon the forces in the particles of the copper causes them to be resolved into a current, by which the resistance is discharged and removed, and the line of force returns to its place. I attach no other meaning to the words *line of force* than that which I have given on a former occasion (2149.).

Royal Institution, Dec. 14, 1849.

ART. XIX.—*Notices regarding the plants yielding the fibre from which the Grass-cloth of China is manufactured.* Communicated by DR. D. J. MACGOWAN,* in a letter to Sir JAMES HUME, Hon. Sec. of the Agric. Society of India.

[IN consequence of communications received last year from Dr. Campbell, Superintendent of Darjeeling, and Mr. T. F. Henly, (Journal, vol. vi, part 1, p. 30,) respecting the superior character of the fibre of the *Kunchoora* of Rungpore, (*Urtica tenacissima*, Roxb.,) in which some observations were made regarding its probable identity with the plant yielding the material for the well known and valuable "grass-cloth" of China,—the Society was induced to refer the matter to Dr. Macgowan, at present stationed at Ningpo, to whose obliging kindness it is indebted for the following interesting particulars, which have been obtained partly by correspondence with scientific friends in other parts of the empire, partly by consulting botanical works and enquiring among the natives, and also from personal observations. It is worthy of remark, that the Society's museum contains several specimens of the fibre of *Urtica tenacissima*, in various stages of manufacture, received from Assam and Cachar, where it is known by the name "*Rheea*;" from the Shan country, where it is called "*Pan*;" and from Ava and the Tenasserim provinces. The plant is commonly met with in those countries; and it is also found in the Straits' Settlements, where it is called "*Ramee*." (See Low's work on Penang and Province Wellesley.) All the correspondents of the Society, from whom specimens have been received at various intervals during the last ten years—Major Jenkins, Mr. Landers, Colonel Burney and Major Macfarquhar, speak in the same terms respecting the great strength, durability and fineness of this fibre. The Shans are stated to use it for every kind of cordage, but the Assamese and natives of Rungpore and Dinagepore, employ it merely for manufacturing into towing lines and fishing nets. The success which has attended the experiments made in Leeds and other towns in Great Britain to manufacture cloth from a mixture, in about equal proportions, of Chinese grass and sheep's wool, having led to a great demand for the former article in a raw state, it becomes a useful subject of enquiry whether the *Kunchoora* of Rungpore, and *Rheea* of Assam, could not be made a profitable article of export in competition with the China material.—*Eds. of Jour. of Agric. and Hor. Society.*]

Sir,—The inquiries you have done me the honor to propose in behalf of the Agricultural Society of Bengal, respecting the plant

* From the Journal of the Agricultural and Horticultural Society of India, for 1848.

from which "grass-cloth" is manufactured, embrace more than can be satisfactorily answered at the present time. The subjoined account, though meagre, and in several particulars incomplete, will be found to contain much of the information you seek. It is cultivated in this vicinity, but as it is of an inferior quality, and does not flower until autumn, my description is less complete than if written in a more favored locality, or at a more advanced season of the year.

Description and History.—Grass-cloth is manufactured from the fibres of a plant, called by the Chinese *Má;* it is a generic term, under which several varieties, if not species, are included, amongst these the *Tung Má*, *Pi Má*, *Sing Má*, *Tien Má*, and others are used only as therapeutic agents. Cloth is manufactured from the *Chú Má*, *Tá Má*, *Kin Má*, *Luh Má*, &c. There is also a species of grass-cloth made from the *Kóh:* all these have likewise a place in the pharmacopœia of China. In imitation of the native botanists from whose works this account has been mainly derived, I shall principally limit my remarks to a description of the *Chú Má*, which belongs to the natural order of *Urticeæ*—it is a *Cannabis* or hemp, but differing from *Cannabis sativa*, sufficiently to warrant another designation. Perhaps until it becomes better known, it may be called *Cannabis sinensis.* It has an irregular cellular root, of a yellowish white color, which sends up annually ten to fifteen, or more stems, to the height of from 7 to 10 feet. The stems are upright, slightly fluted, pilous, and herbaceous: its leaves are on long petioles, alternate, ovate, roundish, serrate, simple; the upper surface pilous and dark green, the lower of a silvery-grey. The flowers are described as minute, numerous, of a light green color, on a catkin-like receptacle or spike. It is found at the base of hills and on dry soils, from Cochin China to the Yellow river, and from Chusan to the farthest west that researches can for the present extend, and abounds chiefly in Kiangsú, Sy, Chuen, Kongnain, Chikiang, Fuchkien, and Canton provinces. Native writers do not include the latter province as its region. It is certainly remarkable, that there is no notice of the *Má* in the work to which you refer, [Fortune's Wanderings in China,] as it is cultivated extensively in many places visited by the author, and grows even on the walls of Ningpo. The plant is mentioned in the Chinese classics, and was undoubtedly cultivated and employed by them a thousand years prior to our era. It is mentioned in the *Shú King* as an article of tribute from the central part of China in the time of Yu, B. C. 2205: doubtless it came into use in far more remote antiquity. The Chinese *Herbal* says, "its origin is unknown."

Medical properties.—The root is described by writers on materia medica as innocuous, sweet to the taste, of a cold nature, and possessed of cathartic properties. The root, seeds, and leaves

are all officinal. A long list of diseases are enumerated in which the plant is efficacious, but these throw no other light on its properties than to suggest it is comparatively inert. It is partly because of its not possessing the narcotic properties of the *Cannabis sativa*, that a difference is presumed to exist between them. In this connection I may remark, that grass-cloth is superior to linen for garments in hot climates, the latter being a rapid conductor of caloric is often unsafe, the former is not so good a conductor, and therefore more suitable. This may be owing either to the fact of the former being hot-pressed in a calender, (by which it is rendered compact and smooth, whilst the process to which the other is subjected for the same purpose, but partially affects it,) or to original differences in the fibres of European and Chinese linen.

Planting the seeds.—This takes place in May. Great care is first taken in the selection of seeds, and in the preparation of the soil. The seed should be gathered on the appearance of frost, those produced from a recent root are the best. After being dried they are stowed away in a basket or jar mixed with sand, or dry earth, others say moist earth. The jar is then covered with straw to protect the seeds from the cold, as if exposed to its influence they yield an imperfect plant. Before planting, the seeds are tested by immersion in water, those which float are to be rejected, those at the bottom planted. A loose dry soil is to be selected, if near a canal or rivulet it is preferable. The ground is to be well ploughed, and broken finely, manured, and then divided into beds about eight yards long, and one wide; the beds are to be raked, and afterwards made compact with a hoe. After this it is watered and left for a night: on the following day raking up and pressing down is repeated. The beds being smooth, two or three table spoonsful of seed are mixed with a bowl of earth, and sown broad-cast over half a dozen beds, then they are swept with a broom to cover the seeds. In some places the seeds are first made to sprout, and then planted in drills, which are carefully filled up. Just before the blades appear, a framework is to be constructed over the beds, on which mats should be spread to protect them from the heat of June and July. The matting must be kept moist by day and removed at night, that the blades may receive the dew of heaven. The beds are to be constantly weeded. When the plant is about two inches high, the framework and matting may be removed. When three inches high, it should be transplanted, having been well watered the night before; the blades should be taken up separately with a portion of earth and planted in a field far removed from mulberry trees, about four inches apart. It may form a border to the ceralia and vegetables, protecting them from the depredations of domestic animals, all of which avoid the *Má*. In dry weather, the field is to be watered every three or four days, until the second decade, when it may

be watered every tenth day. In November and December manure it with horse or buffaloe dung, earth, straw or any rubbish, a foot or more thick, to protect it from cold. In March rake it away and expose the plant, watering it in dry weather, and using rubbish of any kind for manure. A caution is given never to use swines' dung, as it is "saltish" and hurtful to the *Má*. In the third or fourth year, some say in the second, the plant may be cut and used.

Planting the roots.—The roots are to be cut into pieces of three or four fingers' length, and are to be planted in May, half a yard apart, and watered every three or four days. On the appearance of the blades use the hoe and water them; they will be mature for cutting in the second year. In the course of ten years the roots become unfruitful, the shoots may then be cut off, and if enveloped in earth, and covered with matting, can be transplanted in places 30 or 40 inches distant. The ground should be first well prepared with manure, and freely manured afterwards: the manure being half water. Here, as before, the plants should be hoed from time to time. In many cases fresh earth, pulverized bricks, ashes, &c., are used for manure. Some years the husbandman has his crop injured by worms, he needs therefore to seek for and destroy them as they appear by picking them off. It not unfrequently happens, that the crop is in some places remarkably small, and sometimes the produce is very great without assignable cause.

Cutting the Má.—It yields three crops every year. The first cutting takes place in June. Care is to be taken not to cut the young shoots, keep therefore an inch from the ground. In a month or two, the shoots are seven or eight feet high, when the second cutting takes place: do not cut the original stem. During the latter part of September, or in October, the last cutting is performed, from which the finest cloth is made: the first being inferior, coarse, and hard. After each cutting, the plant is to be covered with manure, and watered; but not day by day unless it be cloudy. At Canton the plant is pulled up by the roots every year, from which it is evident that it differs widely from the *Má* just described. Perhaps that which is produced at Canton is *Cannabis sativa*.

Peeling the Má.—On being cut, the leaves are carefully taken off with a bamboo knife, by women and children, generally on the spot. It is then taken to the house, and soaked in water for an hour, unless it is already wet by recent showers. In cold weather the water should be tepid. After this the plant is broken in the middle, by which the fibrous portion is loosened, and raised from the stalk; into the interstice thus made, the operator, generally a woman or a child, thrusts the finger nails, and separates the fibre from the centre to one extremity, and then to the other.

The striping process is very easy. It appears to be difficult to remove the fibres from the Canton *Má*, as it is soaked in water for more than 48 hours before peeling, which is done by men. They first cut off the roots, and then separating the fibre from the stalk, strip it off by drawing it over a pin, fixed in a plank. In either process half of the fibre is taken off at one stroke. The next process is scraping the hemp, to facilitate which the fibre is first soaked in water. The knife or scraper is about two inches long; its back inserted in a handle of twice the length. This rude implement is held in the left hand, its edge which is dull, is raised a line above the index finger. Strips of hemp are then drawn over the blade from within outwards, and being pressed upon by the thumb, the pilous portions of one surface, and the mucilaginous part of the other are thus taken off. The hemp then "rolls up like boiled tendon:" after being wiped dry, it is exposed to the sun for a day, and then assorted, the whitest being selected for fine cloth.

Bleaching and dividing.—A partial bleaching is effected on the fibres, before they undergo further division, sometimes by boiling, and at others by pounding on a plank with a mallet. These operations are in some places repeated. After being dried in the sun, an important operation then succeeds by women and children, to whom is entrusted the tedious process of splitting the fibres, which they do with their finger nails. Expert hands are able to carry this division very far. When this process has been preceded by hatcheling, the shreds are finer and softer. The threads are formed into balls, and subjected to frequent soaking and washings. The ashes of the mulberry leaf are recommended to be put in the water with the hemp, others use lime, for a whole night. Some simply expose it to dew and sun. In rainy and cloudy weather, it should be exposed to a current of air in the house: moisture darkens it. The threads are now ready for splicing, the work of women and children, the labors of the agriculturist being concluded when the threads are rolled into balls, after being sized or stiffened with rice-water. Before the thread is ready for the weaver, the balls are steamed over the vapor of boiling water in a closed oven. They are then spread out to dry. The subsequent stages, until the cloth is removed from the loom, include nothing which interests, or at least instructs, artizans in the West.

Varieties of the Má.—The *Chú Má* is found wild, but in this state attains only three or four feet, and is seldom used except for twine. *King Má* grows nearly as high as the *Chú Má*, the fibre is separated only by rotting in water. The stalks are dipped in sulphur and employed for matches. Its flowers are yellow. Very coarse cloth and sandals are made from its fibre. The thread of this *Má* made in *Kongsi*, is said to be as fine as silk. *Tá Má* or *Hán* (dynasty) *Má*, and also called fine hemp, is like-

wise employed for making cloth and for ropes; its fibre is used as a support to the pith employed as candle wicks. *Luh Má* produces the hemp of which rice bags are manufactured, and also ropes. The *Tung Má* and the *Pi Má* are used for making pigments, one serving for cakes, the other for paper. The only other *Má* that need be named in this list is the *Chí Má*, *Sesamum indicum*. It was brought from India in the reign of Kingti, B. C. 156. It is now found in all parts of the empire. Its seeds are used in cakes, and like almost every kind of *Má*, it yields oil. *Flax.*—It would seem from various English and Chinese Dictionaries, that flax is found in China, but of the existence of *Linum usitatissimum*, I cannot discover the slightest evidence. It seems to have been confounded with the last named plant. The above are all the facts respecting the *Má* which I have been able to glean from native authors; the deficiency can only be supplied by personal observation. The *Chá Má* of this place can be inspected and described when in flower. This imperfect account of the plants producing the fibre from which the grass-cloth of commerce is manufactured (evidently a misnomer), would be yet more defective were the *Kóh* plant to be wholly omitted. It is described as a creeper, which every year springs from an immense root, and grows from ten to thirty feet in length, clinging to trees when within reach. The root is purple on the outside, and white within; it is made into flour like arrow-root. I have found it an useful substitute for the *Maranta arundinacea*. Its leaves have three points, they are long, green on the face, and bright below. In August it has blended purple flowers. The fibre is strongly adherent to the stalk, and is only loosened by boiling it in water. It is then taken off with the finger nails, exposed for a long time to running water, and beaten with mallets. It undergoes the same processes as the *Má*, but seems to require more beating and boiling: wooden utensils make it dark. The *Kóh*, like the *Má*, has been manufactured from high antiquity, and is found throughout the same extensive region in which the latter abounds. The cloth made from it is *yellow*, and as fine as ordinary grass-cloth; it cannot be bleached white; in summer it is much worn by respectable Chinese. The best brought to Ningpo, is called *Háinán Kóh* cloth, and is perhaps manufactured on the island of Háinán. If by the *Kunkhura* you mean the *Urtica tenacissima* of Roxburgh, it is probable that it is a different plant from either variety of the *Má*. As the hindrance to the manufacture of the former is owing to the difficulty attending the peeling of the fibre, would it not be well to treat it, as the Chinese do the *Kóh*, viz. by boiling? If the *Kunkhura* should prove useless, may not the catalogue of Dr. Wallich, which contains forty-seven species of *Urticeæ*, include the *Má*, the *Kóh*, or an available substitute? The observations of Dr. Roxburgh, on

the various specimens of fibrous vegetables, the produce of India, may perhaps be consulted with advantage in connection with the Chinese account of the *Má.* Besides the enclosed, I shall only be able to send you some seeds of the *Chú Má.* There can be no doubt that if the seeds of the proper kind be procured from China, the plant may be introduced into India if it be not indigenous to her soil. To secure success it would perhaps be well to procure them from each of the open ports of China. From Canton is exported the finest cloth manufactured in the empire. This superiority the Chinese attribute to the greater skill of the Canton workmen. Foreigners have referred that fibre to two plants, *Cannabis sativa*, and *Sida tilæfolia* (Dr. Abel).* From Shanghai is exported the fine strong fibre you have referred to, the *Urtica nivea.* It was through the efforts of the H. E. I. Company of Canton, that seeds were procured and forwarded to England. By referring to the 47th page of the 72nd Vol. of the Philosophical Transactions, there will be found a paper on Chinese Hemp by Mr. Furgusson, and a notice of the experiments tried with the seeds in England, (vid. Encyc. Britannica.) Had they possessed the hints here extracted from Chinese writers on this plant, the experiments of the gentlemen named in the above paper would probably have been more successful. Should the Society wish to pursue the subject further, some useful information may be obtained from a series of sketches, 120 in number, illustrating the culture and manufacture of grass-cloth, by Tinqua, 12 New China st., Canton, a translation of the text accompanying the drawings may be found in the Chinese Repository for May, 1847. It was the special province of Monsieur Hedde, of the late embassy from France to China, to collect facts and specimens illustrative of the agriculture and manufactures of China. The result of his observations have, I believe, been published in Paris, containing a notice of one variety of the *Má.* Osbeck, a pupil and countryman of Linnæus, and Dr. Abel, Naturalist of Lord Amherst's embassy, have noticed the *Má.* The Agricultural Society of Bengal, aiming to develope the industrial resources of a great empire, and thereby to improve its inhabitants, has a claim upon the services of all who can contribute in any manner to its objects. Allow me to assure the Society, that I shall take great pleasure in responding to any further calls you may have occasion to make.

Ningpo, June 1st, 1848.

Note by Dr. Falconer.—As there are no specimens accompanying Dr. Macgowan's paper on the grass-cloth of China, it is im-

* It has also been referred to *Corchorus capsularis.* Vide Bennett's Wanderings in N. S. Wales and China.—*Eds. of Jour. of Agric. and Hort. Society.*

possible to decide as to the accuracy of his statement that the fibre is produced by a species of *Cannabis*, which he provisionally calls *Cannabis sinensis*. This point cannot be determined without an examination of the flowers;* and Dr. Macgowan does not appear to have seen them. But the description given by him is entirely that of the species of *Bœhmeria* (formerly *Urtica*), called *B. nivea* or *tenacissima* by botanists, or of a nearly allied species; and I am not aware of any evidence to support the idea that the China grass-cloth (*Chú Má*) is derived from a species of *Cannabis*. One of the other kinds mentioned by Dr. Macgowan, *King Má*, was forwarded to Mr. Roxburgh, from Canton, by Mr. Kerr, in 1812.

ART. XX.—*On the Quantity of Heat evolved from Atmospheric Air by Mechanical Compression;* by JOHN GORRIE, M.D.

(Concluded from p. 49.)

THE arrangement of the following tables is deemed sufficiently clear to render their object intelligible; the first column represents the date of the experiments, and the second the hours at which observations were made and the duration of the experiment. The next three columns represent a series of observed temperatures: the first gives the temperature of the atmosphere; the second shows the temperature of the water used for absorbing the heat of the condensed air, before injection; the third shows the temperature of the same water after the process of injection has enabled it to absorb all the heat it can take up from the condensed air; it also represents the sensible temperature of the air after admixture with the water of injection. Following these, are two columns; the first showing the apparent tension of the air in the reservoir, in atmospheres, as indicated by the gauge; the second the number of revolutions of the engine per minute. The three next columns represent certain quantities of air: the first gives the quantity in cubic inches condensed at each stroke of the pump; the second the quantity in cubic feet condensed per minute; the third, the quantity in pounds avoirdupois, condensed per minute. In calculating this last column I have taken 525 grains as the weight of a cubic foot of air, at a temperature of 60° F. and mean barometric pressure; and applied Dalton and Gay Lussac's law, that it dilates and contracts $\frac{1}{4}\frac{1}{8}$ of its volume for every increase and diminution of its temperature of 1° F. from the fixed point of 32° F. Of the two remaining columns the first shows the

* A second reference has been made to Dr. Macgowan on this point, and specimens will no doubt be shortly received.—*Eds. of Jour. of Agric. and Hor. Society.*

Dr. Macgowan writes that he has forwarded seeds to the Patent Office, Washington, and to the American Institute.

quantity of water in pounds, injected into the condensing pumps, at each stroke of the piston; and the last the quantity of the same water injected per minute.

TABLE I.

Experiment made at Cincinnati.

Date.	Hour.	Temperature of the			Apparent tension of air in atmospheres.	Revolutions of engine.	Quantities of the				
		Atmosphere.	Water before injection.	Water after injection.			Air condensed at each stroke of the pump.	Air condensed pr. minute in cubic feet.	Air condensed per minute in pounds.	Water injected per stroke in pounds.	Water injected per minute in pounds.
1848.	A. M.										
Nov. 21,	11.	42	45								
	11.30	"	"	51	5½	13	3144	47·305	3·627	2	52
	12.	44	"	53 −	6	15	"	54·583	4·210	"	60
	P. M.										
	12.30	"	"	53	6½	"	"	"	4·210	"	60
	1.	46	45+	54	6½	"	"	"	"	"	"
	1.30	45	45	53	6	15½	"	56·400	4·350	"	62
	2.	44	"	56	"	15	"	54·583	4·210	"	60
	2.30	"	"	53 −	"	"	"	"	"	"	"
	3.	"	"	"	5½	"	"	"	"	"	"
	3.30	"	"	"	5½	"	"	"	"	"	"
	4.	"	"	" −	6	"	"	"	"	"	"
	4.30	43	"	"	5¾	"	"	"	"	"	"
	5.	43	"	"	6	"	"	"	"	"	"
Average and difference,				8−	6+	15	3144	54·583	4·210	2	60

Remarks.—In this experiment only the larger condensing pump was used.

The pump being near the steam engine furnace, the air entering it was considered 4° above the open air, (or at 60 F.)

The difference at 2 P. M., of 11° between the water before and after injection, was supposed to be owing to the imperfect working of the jet pump.

In the course of the experiment there were several stops of about 15 minutes each.

From the data presented by the table, it would seem to be an easy matter to form a quantitative determination of the heat evolved by the condensation of atmospheric air. The difference of temperature in the water of injection, before and after injection, the quantity of air condensed, and the quantity of water heated per minute, are all the elements necessary for the calculation at any given tension. By reference to columns 4 and 5, this difference of temperature, in the preceding experiment, is found to be 8° F., the quantity of air condensed per minute, is, accord- to column 10, 4·210 pounds, and column 12 shows that an average of 60 pounds of injection water is heated per minute. A simple multiplication of the first and last numbers, would, if they were correct, show the actual quantity of heat evolved per minute, by the beforementioned quantity of air subjected to a condensation of six atmospheres: Thus, $8° \times 60 = 480°$, is the number

of degrees one pound of water is heated in a minute. If we divide this amount by 140° F., for the latent heat of water, and the standard measure of heat I have adopted, it will give (480÷140=) 3·429, for the number of pounds of ice that the heat would melt per minute. This product being again multiplied by 360′, for the duration of the experiment in minutes, gives (3·429×360=) 1234, or, multiplied by 1440, for the number of minutes in a day, gives (3·429×1440=) 4938, for the number of pounds of ice which the heat evolved in the preceding experiment, would melt in a day.

But there are several circumstances which interfere with this simple calculation, and which require to be considered, and their distinct effects computed before we can arrive at a just conclusion as to the value of the experiment.

1. From the construction of the perforated plates, or "roses," through which the water of injection was delivered to the air in the act of condensation, as well as from the arrangement of the pipes which transmitted the mixture of air and water to the reservoir, I can have no doubt that the latter performed its duty of absorbing as much of the heat set free by the condensation, as possible; but still it could only be a mixture, and the air had, at least, the same temperature as the water. The air was thus possessed of 8° F. more of sensible temperature than when it entered the pump. This additional heat forms an uncompensated equation of temperature of appreciable magnitude requiring an indispensable allowance for its effects. That these were very considerable was rendered evident in the subsequent expansion of the air; for, while besides a diminution of the calculated cooling effects, various parts of the engine, in which the expansion took place, equally exposed to the atmosphere and less favorably influenced for the convection of *cold*, were covered with ice, produced from the condensation of atmospheric vapor, the air-pipe, communicating between the reservoir and the engine, was free from frost or moisture during the continuation of the experiment, though, upon its ceasing, it became speedily covered with frost. In forming an estimate of the proportion which the operation of this free heat bears to the whole of the heat evolved, it seems to be necessary to take into consideration the different specific heats of air under the ordinary atmospheric pressure and the various states of condensation at which experiments may be made.

This is a difficult subject of investigation, and one on which my labors have not led me to satisfactory results, or to an arrangement of them sufficiently clear and accurate to justify my presenting them to the public. But as it is not my present object to solve all the delicate questions which this subject presents, but simply to attain such approximations to facts, as may enable practical men to render them subservient to their purposes, I shall not

enter into the minute examination of this subject. A few experiments are recorded in scientific works which show that the specific heat of air, at different densities, diminishes at a much slower rate than its specific gravity: thus, according to the observations of Clement and Desormes, the specific heat for air for equal volumes, at temperatures from 32° to 140°, and barometric pressure from 3·74 to 39·6, increased in a ratio as follows, viz.

Barometric pressure.		Specific heat.
at	39·6	1·215
"	29·84	1·000
"	14·92	·693
"	7·44	·540
"	3·74	·368

From this table it is apparent that the specific heat of atmospheric air, considered in the ratio of its weight or mass, diminishes as the density increases; and it may be calculated, that when air in the same volume is condensed to double its density, its specific heat is increased from 1·000 to 1·467; when its density is quadrupled it becomes 1·883; and when its density is eight times increased its specific heat is 2·717. The densities increasing in the geometrical progression 1, 2, 4, 8, correspond nearly to the specific heats in the arithmetical series, 5, 4, 3, 2.

If the view I have taken of this law be correct, and it be applicable to an explanation of the heating operation of air in the condition referred to, we are prepared to examine the extent of its influence. Before, however, this can be determined, we must form an estimate of the whole amount of heat evolved by and at the specific heat of air, under a given degree of condensation, in order to assign the proportion that belongs to that in the reservoir. By referring to the 10th column of the preceding table, we find that an average of 4·210 pounds of air condensed with a force of six atmospheres, heats 60 pounds of water 8° F., or, that one pound of air heats 14·250 pounds of water 8° F., or, that one pound of air heats one pound of water 114° F. As the specific heat of air at ordinary temperature and pressure is 2669, one pound of it, in evolving heat enough to warm an equal quantity of water, 114° F., must set free what would heat itself, 427° F., besides the 8° F., which, in the experiment, it retained above the atmospheric temperature. Under a condensation of six atmospheres the specific heat of air, we have seen, is about 2·500; and this amount must be multiplied by 8° F., for the extra temperature of the air in the reservoir, making 20° F. to enable it to represent its proportional heating effect. Now, the proportion of 20° F. (the equivalent to the free heat in the reservoir) to 427, (the remainder of the heat evolved by

condensation) is, nearly, as 1 to 21; and, therefore, the relation of the heat retained by the air, after admixture with the water of injection, is equal to about one twenty-first part of the 8° F., which the water of injection absorbs, or is about the $\frac{1}{168}$ of a degree of Fahrenheit at the specific heat of water.

2. Another correction of the table is necessary on account of the heat of condensation, which the water of injection is unable to absorb, imparting an increased elasticity to the air in the reservoir. This air being confined within fixed bounds, the effect of the heat is to increase its pressure on the surface by which it is confined, instead of the natural one of enlarging its dimensions. The consequence is that the gauge of the reservoir marks a higher tension than it would have if all the free heat of the air were absorbed. The actual changes of elasticity which are produced by mechanical condensation, without allowing the compressed air to lose any heat after compression, and for all proportions in which that heat is retained, have been mathematically investigated. They are expressed, however, by theorems too abstruse, in comparison with the importance of the object to be at present attained, to find a place in this communication. Possessing a more important bearing upon the quantity of cooling effect produced by the expansion of condensed air, and still more in a relation with the quantity of mechanical power consumed in the condensation of air, they will be examined more minutely when I come to consider these portions of my subject. At present I deem it sufficient to say that, from the partial calculation I have made, I feel authorized to consider that 8° F. of unabsorbed heat add to the elasticity of air, under a tension of six atmospheres, about one-third of an atmosphere of pressure.

3. Radiation is a cause of diminution of the apparent heating effect from the condensation of air, requiring a correction for perfect accuracy. The loss of heat from this cause is dependent somewhat upon the nature of the material and extent of surface, but more upon the difference between the temperature of the hot body, and that of the surrounding medium. As this difference, in the case before us, is but 8° F., the rate at which heat is lost must be very small, and scarcely appreciable by instruments.

4. A correction of an opposite character must be made for the heat generated by the friction of the piston and piston rod of the pump. Attempts were made, in the course of this and other experiments, to ascertain the precise quantity of heat generated by this means, but they were not successful. Upon propping open the induction valves of the pump, so as to allow free ingress and egress to the air, while the piston worked and the water of injection flowed as usual, I could not perceive by the thermometer, any change in the temperature of the water. Yet all experience

proves that heat is generated by friction; and Rumford has shown that the quantity is very considerable. According to an experiment directed towards attaining the maximum heating effect from this cause, he found that a mechanical force of one horse power evolved heat enough to raise the temperature of $26\frac{1}{2}$ pounds of water 90° F. in $2\frac{1}{2}$ hours; which, it may be easily calculated, is sufficient to melt $6\frac{2}{3}$ pounds of ice per hour. I consider that upon the principle on which the friction of the steam engine and similar machines is usually calculated, the condensing pump, used in this experiment, consumed nearly one-half of a horse power. If this assumption be correct, and Rumford's experiment be considered a standard formula for such calculations, the heat generated by the piston and piston rod must have been equivalent to the fusion of about eighty pounds of ice per day; or was equal to an increase of temperature of $(80 \div 5000 = 8° \div 625)$ ·125 of a degree.

Applied to the data of the preceding table, these corrections will make the whole amount of heat evolved by air, compressed with a force of six atmospheres, as follows:

Heat as shown by the water of injection, . . .	8°
" added, for correction 1, ...	·375
" " " " 2 } estimated at . .	·125
" " " " 3 }	
	8°·500
" deducted, for correction 4, ...	·125
	8°·375

Now, as 60 pounds of water were heated 8°.375 per minute, heat enough must have been disengaged, by the machine, to melt $(60 \times 8°{\cdot}375 \div 240 =) 3{\cdot}575$ pounds of ice per minute or $(3{\cdot}575 \times 144 =) 5660$ pounds per day.

Having explained in a general way the principles concerned in correcting the data, furnished by experiment on our mode of determining the heat evolved by the condensation of air, we are prepared both to exhibit and correct any number of experiments. The principles are seen to be general conclusions, affording approximations only to the position in which truth lies, and requiring modifications before they can be considered representations of actual facts. They are therefore of value, chiefly, as guides in future experiments, by which they may be confirmed, or, if erroneous, rendered accurate. Such as they are, I have applied them to the correction of the following tables.

TABLE II.

Experiments made in New Orleans.

Date.	Hour.	Temperatures of the			Apparent tension of air in atmospheres.	Revolutions of engine.	Quantities of the				
		Atmosphere.	Water before injection.	Water after injection.			Air condensed at each stroke of the pump.	Air condensed per minute in cubic feet.	Air condensed per minute in pounds.	Water injected per stroke in pounds.	Water injected per minute in pounds.
1849.	A. M.										
June 23	10	82	79	84	2	22	3144 / 206	85·300	6·093	2	88
" 29	P. M. 1.	82	79	82	"	18		69·791	4·985	2	72
" "	1.30	"	79	84	"	"	"	"	"	"	"
" "	2.	83	79	84	"	"	"	"	"	"	"
	A. M.										
July 25	7.30	79	76	80	"	17	"	65·914	4·708	2	68
" "	8.	82	79	84	"	"	"	"	"	"	"
" "	9.	"	79	84	"	"	"	"	"	"	"
" 26	8.	84	77	82	"	"	"	"	"	"	"
Average and difference, 5° –					2	18	3350	69·791	4·985	2	72

Remarks.—In these experiments both pumps were used. The observation on the experiment of June 23, was made while the reservoir was being rapidly charged to 8 atmospheres. In the other experiments the tension in the reservoir was steadily maintained at 2 atmospheres.

This table is drawn up from experiments made on four different days, and under some variations of circumstances, in regard to the temperatures of the atmosphere and water of injection, as well as the manner in which they were performed. The resulting difference between the temperatures of the water before and after injection, after the pump and its appendages were raised to a temperature common with the latter, was so nearly uniform, for all the experiments, that it may be considered identical. It shows, according to the thermometers used, that two pounds of water were heated 5° F. at every stroke of the pump; or, that 3350 cubic inches of air, compressed till its density was doubled, heated two pounds of water 5° F. This is a little above the average, and it may be more correct to consider the amount of heat 4°·75.

To this must be added for correction, 1, on account of heat retained by condensed air, ... 2·50

" " " " 2, " " of over-estimate of pressure of air, } ·175

" " " " 3, " of radiation, }

5·175

From this must be deducted for correction 4, on account of heat from friction, ... 42

5·133

The causes interfering with the accuracy of operations of the present character are so delicate and intricate in their nature that

it cannot be expected a few experiments should be deemed sufficient to settle them with mathematical precision; yet, we cannot err on the side of too great a quantity in assuming that fully $5\frac{1}{8}°$ is the action of the aforementioned quantity of air, condensed to double its density, from its atmospheric condition, upon the specified quantity of water.

TABLE III.

Experiments made in New Orleans.

Date.	Hour.	Temperatures of the			Apparent tension of air in atmospheres.	Revolutions of engine.	Quantities of				
		Atmosphere.	Water before injection.	Water after injection.			Air condensed at each stroke of the pumps.	Air condensed per minute in cubic feet.	Air condensed per minute in pounds.	Water injected per stroke in pounds.	Water injected per minute in pounds.
1849.	A. M.						3144				
June 23	10.10	82	79	85	4	18	206	69·791	4·985	2	72
	P. M.						3350				
" 25	12.30	84	78	84	"	15	"	58·015	4·144	"	60
" 29	4.	80	80–	86	"	17	"	65·914	4·708	"	68
" "	4.15	79	79	86	"	"	"	"	"	"	"
	A. M.										
July 25	11.30	84	79	85+	"	15	"	58·015	4·144	"	60
" "	12.	"	79	86	"	18	"	69·791	4·985	"	72
	P. M.										
" "	12.45	"	79	86	"	16	"	62·037	4·431	"	64
	A. M.										
" 26	8.	82	77	84	"	15	"	58·015	4·144	"	60
" 27	8.	"	77	83	"	17	"	65·914	4·708	"	68
" "	9.30	86	78	84+	"	16	"	62·037	4·431	"	64
" "	10.30	84	78	84+	"	15	"	58·015	4·144	"	60
	M.										
" "	12.	86	78	85	"	16	"	62·037	4·431	"	64
Average and difference,				7°	4	16	3350	62·037	4·431	2	64

Remarks.—The tension in the reservoir, as marked by the gauge, was seldom at exactly 4 atmospheres; it was sometimes a little above and sometimes a little below the mark.

The difference of temperature between the water before and after injection I consider as full 7° F.

From this table it may be deduced that the condensation of 3350 cubic inches of air, at the ordinary pressure, and a mean temperature of 84°, to one-fourth of its volume, disengages heat enough to raise the temperature of two pounds of water 7° F. Applying the principles of correction heretofore established, we must add for correction on account of heat retained by the condensed air, ·333

7·333

Add for correction number 2 } estimated at, . . ·110
" " " " 3 }

7 ·443

Deduct for " " 4 heat from friction, . 83

7°·360

TABLE IV.

Experiments made in New Orleans.

Date.	Hour.	Temperatures of the			Apparent tension of air in atmospheres	Revolutions of engine.	Quantities of				
		Atmosphere.	Water before injection.	Water after injection.			Air condensed at each stroke of the pumps.	Air condensed per minute in cubic feet.	Air condensed per minute in pounds.	Water injected per stroke in pounds.	Water injected per minute in pounds.
1849.	P. M.						3144				
June 18	1.15	80	79	87	8	20	206	77·542	5·538	2	80
							3350				
" "	2.	"	79	88	"	"	"	"	"	"	"
July 26	1.	74	77	86	"	15	"	58·015	4·154	"	60
" "	1.30	78	77	88	"	"	"	"	"	"	"
" "	2.30	82	77	86	"	16	"	62·037	4·431	"	64
" "	4.30	"	"	85	"	15	"	58·015	4·144	"	60
" "	5.30	"	"	85	"	"	"	"	"	"	"
" 27	12.30	"	78	86+	"	16	"	62.037	4·431	"	64
" "	1.30	84	81	89	"	15	"	58·015	4·144	"	60
" 28	1.40	82	78	86+	"	"	"	"	"	"	"
" "	3.15	"	"	86	"	16½	"	63·975	4·569	"	66
" "	5.30	86	79	87+	"	16	"	62·037	4·431	"	64
" "	7.45	82	78	86+	"	"	"	"	"	"	"
Difference and average,				8¼° F.	8	16	"	62·037	4·431	2	64

Remarks.—On July 26, at 1°.30′ it will be observed the difference of temperature of the water of injection, before and after injection, was 11° F. This unusual quantity of heat, as in the first experiment, was supposed to be owing to imperfect working of the jet pump, thereby causing a less than the regular quantity of water to be injected.

As in the former tables, the data for table IV. are taken from experiments made on different days. It appears from a comparison of the fourth and fifth columns, that the difference in temperature of the water, before and after injection, several times indicates 9° F., but as it was oftener simply a full 8° F., I have not thought advisable to take 8°·5 for the mean of observation, though I feel assured there can be no exaggeration in considering it . . . . . 8°·250

Add for correction number 1 . . . . . ·400

" " " " 2 } . . . . . ·135
" " " " 3 }

8 ·785

Deduct for " " 4 . . . . . ·125

8 ·660

In the deductions I have made from the preceding tables, I have supposed that the allowances for the real over the apparent pressure of the air in the reservoir, and for radiation, are about equal to the opposing effect from friction. According to the mode of proceeding we shall have 8°·660 as the quantity of heat evolved from 3350 cubic inches of air as subjected to a compressing power of eight atmospheres at a temperature of about 84° F.

I have deemed it necessary, for a full elucidation of the subject before us, to append a table of deductions, drawn up from some of the data furnished by the preceding tables. In explanation of this table it may be stated that the first column is intended to represent the mean temperature of the atmosphere during the time of the experiment. Column 2 gives the mean difference between the water of injection before and after injection; and the 3d is designed to show the difference, in the same water, under the various corrections which must be made upon the simple thermometrical observations. The 4th column represents the tension of the air in the reservoir, according to observation; and the 5th the same tension as corrected for excess of temperature.

To enable us to compute the effects without great and undue labor, it is necessary to reduce both the air and the water, used in the experiments, to some common measure or weight. The pound weight as the most convenient standard, has been adopted. By reducing columns ten and twelve, of the preceding tables, to the common rate, we have obtained column 6 of the following table.

The 7th column shows the quantity of heat set free by the condensation of one pound of air at the specific heat of air. The figures in the column are ascertained by assuming that the specific heat of air—assigned by Delaroche and Berard, viz., ·2669 water being 1·0000—is correct, and then multiplying the quantity by the number of degrees, F., one pound of air heats one pound of water, under a given degree of compression, as shown in column six. It is in truth a mere representation of the intensity of heat evolved by the simple condensation of air.

Columns 8 and 9 show the quantity of heat—expressed in the number of pounds of ice it would melt—which the engine is capable of producing in twenty-four hours, at fifteen and twenty revolutions per minute; and are introduced as suggestive of pecuniary considerations.

The 10th and 11th columns show the difference in the degrees of heat, at the specific heats of water and air, which the air in certain states of condensation disengages.

As my object, in conducting the foregoing experiments, has been to furnish practical rather than scientific data, I have not thought it appropriate to introduce the calculations of the following table in full, nor have I attempted their perfect accuracy. The results set down for the tension of 3, 5 and 7 atmospheres must be considered as rather the deductions of careful conjecture than the precise answers to either observation or calculation. It is no doubt practicable to make observations which shall express a very close approximation to the actual temperature evolved from air, for all tensions; but it would require thermometers of much

greater delicacy and accuracy than I could obtain, and some modifications of the mode of experimenting pursued. It is, therefore, desirable on both scientific and practical grounds, that a more extended series of experiments on air, similar to those above detailed, should be made, with such improved and superior apparatus, as experience has demonstrated is necessary, and with the care and skill which none but those practised in such matters are competent to exercise. In the mean time, the following table may be regarded as sufficiently near to truth to present a plain view of the objects for which it was drawn up; and any one who is so disposed may test its general correctness by particular examples.

TABLE V.

Deductions from Tables 1, 2, 3, 4.

Mean Temperature of					Quantity of heat set free by the condensation of						
The atmosphere.	The difference between the water before and after injection.	Corrected difference between the water before and after injection.	Apparent tension of air in atmospheres.	Real tension of air in atmospheres.	One pound of air at specific heat of water.	One pound of air at specific heat of air.	Air expressed in pounds of ice per day, at 15 revolutions of engine.	Air expressed in pounds of ice per day, at 20 revolutions of engine.	Ratio of difference of heat set free at specific heat of water.	Ratio of difference of heat set free at specific heat of air.	Remarks.
83	5°.–	5.125	2		74.	277	3112	4220	74.	277	By observation.
"	6 .5		3								" calculation.
84	7.–	7.333	4		105.	395	4474	5966	31.	118	" observation.
"	7 .5+		5								" calculation.
46	8.–	8.333	6	5.666			5150	6866			" observation.
83	8.+	8.500	7								" calculation.
"	8°.25	8.666	8	7.500	125.	472	5343	7125	20.	80	" observation.

Before adverting to the particular object for which the foregoing table was drawn up, I may mention that the question of the quantity of heat evolved by air, under a tension of eight atmospheres, was subjected to another and very simple test, which confirmed the accuracy of the deductions comprised in the last line. During an experiment of an hour's duration, the water of injection, instead of being supplied as usual by the city hydrant, was taken from and returned to a butt of about 130 gallons capacity, containing about 1100 pounds of water. At the commencement of the experiment, the temperature of the water was 77° F. (the atmosphere being 79° F.), at the end it was 112° F., the engine working twenty revolutions a minute. The quantity of ice, which the heat thus disengaged would melt, is equal to $(1100 \times 35 \div 140 =) 275$ pounds, or for twenty-four hours 6600 pounds. There was but a very slight diminution in the rate at which the temperature of the water increased.

In corroboration of the general accuracy of the experiments it may be further mentioned, that the converse of the result here sought, viz., the quantity of heat which the condensed air in its expansion is capable of absorbing, or, in other words, the quantity of ice it is capable of producing, was, after making due allowances, sufficiently nearly equal to the quantities as set down in columns eight and nine, to prove that there has been no material error of observation or calculation.

The chief object of Table V. is to present in a form obvious at a glance, the changes of temperature which correspond to proportional changes in the density of air. Philosophers have so often found the phenomena of nature conforming, in all their circumstances, to uniform laws, that they seem to have supposed the evolution of heat, from the mechanical condensation of air, must follow some course of regular progression. The convenience to experimenters which has resulted from the establishment of that law by which aerial bodies adjust their volume and pressure exactly to each other, has induced them to hope that one equally simple would be discovered for measuring the proportion of heat set free from air by condensation. And, under the impression that such a law must exist, equal proportions of heat have been considered to be set free, under regular diminutions of volume, or increase in density of air. Thus, Dalton, finding, on experimenting with a small quantity of air, that when it was doubled in density it evolved 50° F. assumed this as the measure for every subsequent doubling of its density. Leslie, observing a similar result, from restoring dilated air to its natural density, assigned a similar quantity of heat to a similar reduction of volume; but as a law founded on such a result was incompatible with the phenomena presented by a greater increase of density, he deduced the following rule for determining the change of temperature produced by any degree of rarefaction or condensation of air, viz.: "Multiply 25 by the difference between the density of air and its reciprocal, the product will be the difference of temperature on the Centigrade scale." Thus, if the density be doubled or the rarefaction reduced to one half, $25\times(2-\frac{1}{2})=37\frac{1}{2}°$ Centigrade ($=67\frac{1}{2}$ F.) indicates the change of temperature by doubling the density or rarity of air. By this formula the quantity of heat evolved by the higher degrees of condensation is enormously increased; for if the air were condensed 30 times we should have $25\times(30-\frac{1}{30})=749°$ Centigrade (1412° F.) for the elevation of temperature. It may be remarked of this reasoning that it represents an hypothesis more nearly the reverse than in conformity with any natural law, of an increase or reduction of temperature, deducible from experiment. Mr. Ivory, acting upon a similar view of natural progression, expresses a rule for the changes of temperature, corresponding to given changes of density, by as-

signing 1° F. as the quantity of heat evolved from air, under a reduction of $\frac{1}{1\,\frac{1}{8}}$ of a volume, no matter of what density. The preceding tables of experiments, however inexact they may be, are sufficiently extended and precise to prove that all the above formulæ are erroneous.

But so probable, at the outset of my experiments, did it appear that the relation between the condensation of air and the disengagement of heat, followed some law of arithmetical or geometrical proportion, and so firmly was the probability impressed on my mind, that observations of a different tendency produced only doubts of their accuracy. The quantity of heat obtained by reducing air from its atmospheric state to half its volume, I assumed as the basis of a calculation for every subsequent similar reduction, until frequent repetition of the experiment taught me the error and the necessity of a different conclusion.

An inspection of columns 6, 7, 10, 11, of Table V, will prove that all previous estimates of the heat set free by a change in the density of air, as well as all supposed natural laws of regular progression, adopted in connection with them, must be inaccurate. This apparent deviation from the general practice of nature admits of an explanation. Variations of pressure, and variations of heat evolved in consequence, follow each other as cause and effect; yet, there is an interference, particularly in respect to äerial bodies, arising from their property of elasticity, which prevents these variations from being equal in different cases. The cause of volume and the cause of elasticity are the same, and this is undoubtedly caloric; and the difference between them is dependent upon a modified affinity for this principle, which appears to increase, in proportion as the pressure the elastic body is subjected to is greater. In consequence of this growing affinity, the tension of air must increase in a much greater ratio than the quantity of heat set free during the reduction of volume.

In the experiments, as recorded, all preconceived notions of a uniform law of progression of any kind were set aside, and nothing were regarded but the quantity and tension of the materials employed, and the indications of the thermometer. The experiments, indeed, show that if there is any precise law of progression, or fixed relation between an increase of tension and the amount of latent heat set free in air by it, it must be in an inverse and rapidly diminishing ratio. Thus, the quantity of heat generated by compressing air to half its volume, is, as shown in columns 6 and 7, sufficient to elevate the temperature of an equal weight of water 74° F. and of its own body 277 degrees F. When it was reduced to one-fourth of its volume the increase of heat became for water 105° F. and for air 395° F.; and when condensed to one-eighth of its original volume, the heat was, for water, 125°, and for air 472° F.

According to these observations and deductions, while the densities of air increased in the geometrical progression 2, 4, 8, the heats evolved corresponded, nearly, to the arithmetical series 3, 4, 5. But the ratio in the differences of temperature between the assigned densities followed a very different rate of progression from either; thus for the densities 2, 4, 8 atmospheric pressures, the corresponding differences of heat evolved were in the decreasing numbers, nearly, (277, 118, 80) 3·5, 1·5, 1.

I deem it highly probable that the foregoing deductions are very near to true expositions of the relations between the condensation of atmospheric air, and the evolution of its latent heat. The discrepancies between the actual observations and the numbers which should belong to a law of progression, are more reasonably to be referred to error in the former than in the latter. A slight examination of the tables will shew how very important it is in such experiments, that the instruments for making observations should be both delicate and accurate. It has been mentioned that the thermometers used could not be relied upon within half a degree of their indications; while an error to this extent would produce a difference in the deductions of the first line of Table V, of one-tenth part and, of course, materially affect the value of the experiment. Besides the necessity of proper philosophical instruments, the series of observations on both densities and temperature ought to have been more extended to justify the attempt to establish a natural law from their deductions. So well aware was I of the importance of an extended succession of observations, that in drawing up the design of the machine, I endeavored to adjust its proportions so that it should be capable of working to a tension of sixteen atmospheres; but on trial, many portions of it were found too weak to sustain such a pressure. I will, however, repeat that such experiments as the machine admitted of being made, have been made under a full conviction of their importance, and with a determination that nothing should be noted which my own senses did not perceive, nor set down but as the result of repeated and confirmed observation; and, notwithstanding the imperfection of instruments and machinery, I am of opinion that they cannot be in error to any considerable extent, nor can I hesitate to recommend them to public confidence.

Apalachicola, March 7, 1850.

Art. XXI.—*Notice of Remains of Vertebrated Animals found at Richmond, Virginia;* by Jeffries Wyman, M. D.

The remains which are the subject of this notice were discovered in the tertiary beds which form the foundation of the city of Richmond, and which extend beyond its limits over a vast area. Mr. Conrad regarded these beds as identical with the English crag under the name of "medial pliocene," and Professors W. B. and H. D. Rogers describe them under the name of Miocene.* The opinion of these last geologists is confirmed by the observations of Sir Charles Lyell.† Prof. W. B. Rogers informs me in addition that in the bottom of some of the ravines, a stratum exists containing Eocene fossils.

A large proportion of the bones and teeth here described were discovered and exhumed by Dr. Martin Burton of Richmond, in the various ravines which intersect this city and its vicinity, but more especially those at its eastern and western extremity. The largest ravine, the one through which Shockoe creek makes its way into the James River, is about one hundred feet in depth and many hundreds in breadth. From this there branch off on either side many smaller ravines with nearly vertical walls. The most remarkable of these are on the western side. On the eastern slope there are none so deeply cut, but on the bottom of them may be seen a layer of silicious animalcular deposit which was noticed by Profs. Rogers. Prof. J. W. Bailey of West Point, has shown that it contains many species of infusorial forms in vast numbers.‡ This stratum, according to Prof. W. B. Rogers, is near the lower limit of the Miocene in that vicinity.

In the Miocene deposits are found the remains of Vertebrata in great numbers, especially of Sharks and of a small species of Myliobatis. The infusorial stratum and the strata immediately above it contain stones of very small size only, and give no evidence of rapid currents of water or of heavy waves; every thing seems sedimentary in its character. More superficially is a deposit of clay containing casts of Pecten in great abundance, and above this, rounded stones become quite numerous, and are used for the purpose of paving. On the recent removal of a portion of Mayos hill, a stratum of dark blue marine mud was exposed in which were discovered pieces of drift wood, still preserving their general characters, and even their microscopic structure, though so soft and decayed as to yield to very slight pressure from the fingers; its tenacity was so slight that it became difficult to remove the pieces without breaking. In some instances they were

* Trans. Am. Philos. Soc., Philad., 1836.
† Proceedings Geolog. Soc., Lond., Feb. 26, 1845.
‡ See Prof. Bailey's several articles in Am. Jour. of Science.

perforated with canals similar to those made by the Teredo. If the wood thus discovered were allowed to dry in the open air, as its moisture evaporated, it became more and more solid, and soon assumed the constitution of lignite, having the density, brittle fracture and shining surface of coal. The progress of this change I had an opportunity of noticing in a piece of wood which lay on my table from the time it was exhumed until it was completely converted into lignite. Fruits well preserved were occasionally found, and in one instance a nut which was recognized by Prof. Agassiz as belonging to the genus Carya or hickory. I have as yet seen but very few unequivocal remains of reptiles. These consist of a few teeth which will be noticed in a subsequent portion of this paper. Coprolites have also been found in great numbers some of them of unusual large size.

Remains of Mammals.—*Seals.* Among the most interesting of the relics discovered by Dr. Burton were parts of the cranium of an animal belonging to the natural family of Phocidæ, a family of which but few remains had been previously detected, and in so far as I have been able to find any record, only in one other locality in the United States. The bones were fragile, and had evidently been crushed previous to exhumation. The pieces in my possession consist of two temporal bones nearly entire, a fragment including a portion of the parietal and occipital bones, and in addition a part of the base of the skull. The reëntering angle of the occiput, the well marked depressions corresponding with the cerebral convolutions on the parietal bones, the form of the cranial cavity, the deep fossa above the internal auditory foramen, the vascular canals opening on the occiput, and the inflated tympanic bones, all indicated an affinity to the Phocidæ. The size varied but little from that of the common Harp seal, (P. Groenlandica.) The presence of an interparietal crest indicating a large development of the temporal muscles, offers a diagnostic sign by which it may be distinguished from P. barbata, P. Groenlandica, P. hispida, P. mitrata, and P. vitulina. From those species of seals which are provided with a crest the fossil presents a well marked difference in having the mastoid process much larger, more rounded, and prominent, nearly equalling the tympanic bone in size. The entrance to the carotid canal is in full view when the base of the skull is turned upwards. The imperfectly divided canal which lodges the Eustachian tube and the tensor tympani muscle is of remarkable dimensions, especially when compared with that of P. Groenlandica. The interparietal crest extending from the occiput to the anterior edge of the frontals, is most narrow posteriorly where it is but slightly elevated above the surrounding bones.

The fragments of cranium above described were found in the Shockoe creek ravine near the base of Church Hill. In the ravine at the eastern extremity of the city and in the neighborhood of

the penitentiary, Dr. Burton obtained several other portions of the skeleton of another seal. These consisted of an imperfect cervical vertebra, a lumbar vertebra nearly entire, a fragment of the sacrum, coccygeal vertebra, fragments of ribs and the lower extremity of a fibula. Their generic characters have been satisfactorily made out by comparisons with recent bones.*

In figure 1, page 232, I have represented the coccygeal vertebra which corresponds in its general characters very accurately with recent bones of P. Groenlandica from the same region of the vertebral column. The small size of the vertebral canal and the imperfect transverse process, the wide spread articulating processes and the blunted spinous process indicate its affinity to the seals.

The fragment of a left fibula (figs. 2 and 3) presents at its lower extremity (fig. 3), an oblique regularly concave articulating surface, on its inner face, and on its outer (figs. 2 and 3,) an elevated ridge or crest on either side of which is a groove for the passage of a tendon.

Phocodon, Agassiz.—Of this interesting genus, (which is so nearly allied with *Squalodon* of Grateloup, *Basilosaurus* of Harlan, *Zeuglodon* of Owen and J. Müller, *Dorudon* of Gibbes, and the remains from which the empirical *Hydrarchos* of Koch was made, I have received from Dr. Burton only a single tooth, which was identified by Prof. Agassiz.†

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* The only other locality for fossil bones of seals which I have seen noticed as occurring in the U. States, is the one mentioned by Dr. C. T. Jackson (in his final Report on the Geology of New Hampshire) at South Berwick, Maine, in marine mud, about thirty feet below the surface, and which were brought to light on digging a well. These were sent to me for description and proved to be an ulna and a radius.

Cuvier in the last edition of the Ossemens Fossiles (t. viii, p. 454) after having set aside many pretended discoveries, says: "en effet rien n'est plus rare que des os de Phoques, et de Lamantins parmis les fossiles." "Je n'ai pu obtenir d'ossemens fossiles de phoques bien' constatés que des seuls environs d'Angers."

The fragments described by Cuvier as belonging to two individuals, were subsequently asserted by Blainville to belong to one and the same bone, and were shown to be those of a Manatee instead of a Seal, a discovery on which M. de. B. dwells with peculiar satisfaction. Osteographie, Genus Phoca, p. 40.)

Among the veritable discoveries of the remains of fossil seals, Blainville cites the following. (Osteograph., Gen. Phoca, p. 41.)

1. Teeth from Maestricht, accompanied with those of sharks. Boué, Journ. de Geol., t. iii, p. 31.

2 Teeth, a vertebra and a cranium, found in Westphalia. Hermann von Meyer, Paleologica, p. 131.

3. Also from the same authority, teeth very similar to those of seals, and of sharks, from Laxberg near Aix la Chapelle.

4. A fragment of an ilium is referred to, described by Eugene Robert, found in the shell tufa of Iceland with Cyprina Islandica and other recent shells. This is probably from an existing species.

5. In the Museum of Perth, Hungary, exists a hind foot, found near Vienna in the valley of the Danube.

† Prof. A. will soon publish a complete memoir, on this genus found in the United States, in which will be given the result of his personal observations drawn from large collections of remains.

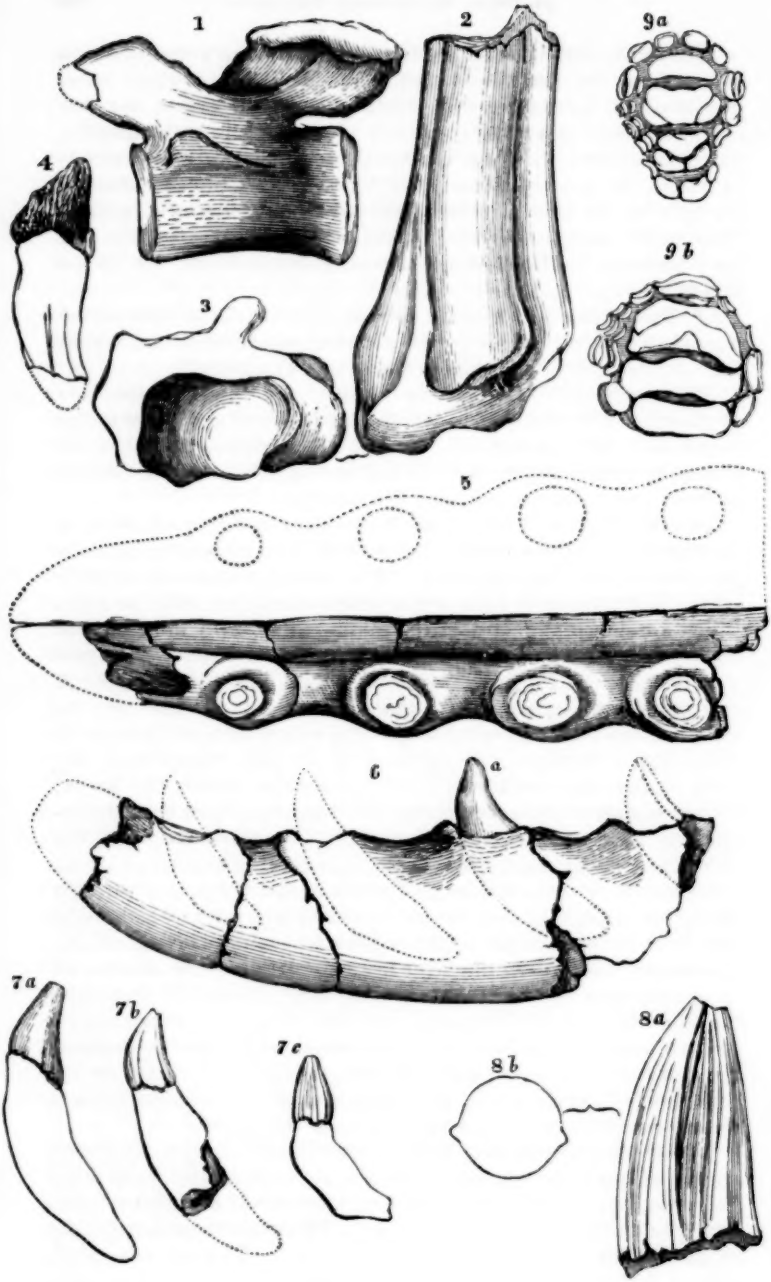
This tooth (fig. 4,) is $1\frac{3}{5}$ inch in length, having a small portion broken from the end of its root. The crown is conical, compressed on its inner face, with slightly trenchant edges, the posterior of which is provided with a slightly projecting tubercle. The enamel over its whole surface is roughened by small irregular ridges, the general direction of which is from the base towards the apex of the crown, those at the apex being the most minute. This tooth must have been placed at the anterior part of the jaw; all those of the posterior lateral portions being deeply indented.

Dr. Burton has also found a petrous bone with its convoluted appendage, which has all the Cetacean characteristics and which Prof. Agassiz likewise refers to the genus Phocodon.

Delphinus.—From the same locality and in the immediate neighborhood of the spot in which the vertebræ and other bones of the seal were found, Dr. Burton obtained four vertebræ all belonging apparently to one individual and nearly of the size of those of the common porpoise, (D. delphis.)

The fragment of a lower jaw represented in figures 5 and 6, if the indications of the teeth are followed, is Cetacean, though the jaw itself is somewhat unusual. The crowns project but slightly above their alveoli, and are small when compared with the roots which are long, bulging near the middle and deeply imbedded in their sockets. The extent to which they penetrate into the jaw is made obvious by three fractures, which intersect the alveoli near their termination. A reptilian feature in the jaw may be recognized in the depressions or grooves which exist on its sides in the intervals between the teeth, as if for the reception of the teeth of the upper maxillary bone, a condition which Dr. R. W. Gibbes has shown to exist in the Basilosaurus. Each tooth is surrounded by a distinct circular ridge. The teeth are solid, the pulp cavity being wholly filled up. By reference to figure 5 it will be seen that the two halves of the lower jaw are united through the whole extent of this fragment (the symphysis) by a flat surface as is the case in the sperm whales and in the Gavials among Crocodiles. It differs however from the latter in the absence of an enlargement of the jaw at its extremity, (gradually diminishing to a point as in Cetaceans,) as well as in the deficiency of teeth of larger dimensions which in Gavials correspond to canines. Were it not for the prolonged symphysis the jaw might be regarded as belonging to the genus Phocodon. In its symphysis it closely resembles that of some species of Delphinus.

The teeth represented in figure 7, are regarded as belonging to an animal of the same species as the jaw above described, presenting the same form of the crown and root represented at *a* figure 6, the only one which was preserved entire. These teeth are either solid or provided with only a minute pulp cavity. This jaw resembles that of Delphinus more closely than that of any other Cetacean.


1
2
9a
4
3
9b
5
6
a
7a
7b
7c
8b
8a

This fragment I found in one of the small ravines on the western side of the Shockoe Creek Ravine.

In one of the species of Zeuglodon figured by Müller, there exists a lower jaw with a prolonged symphysis as in the above specimen, though the teeth of the first are less numerous. He also figures a portion of an upper jaw which is turned up, presenting a convexity corresponding with the concavity of the outline of the lower fragment here described. Fig. 6.

In addition to the above, there have been found from time to time for many years, fragments of bones of the larger Cetaceans of which I have numerous specimens, but have seen none of the dimensions of those of the largest existing whales. Their specific characters have not been recognized. I have a single imperfect tooth nearly five inches in length, the crown of which is quite small compared with the root, and its surface is irregularly striated or reticulated as in the figures of the teeth of Zeuglodon, given by Johannes Müller in his memoir on this last animal.

Reptiles.—The only remains which represent this order are teeth, one of which is represented in figure 8 *a* of its natural size and which is obviously that of some species of Crocodile. Its form is blunt conical, with a transverse section nearly circular, and having on each side a small and well defined ridge largest at its upper extremity and terminating below in a delicate point. The surface of the tooth is marked with minute longitudinal striæ. The lateral ridges divide the tooth into two unequal portions as shown in the section, figure 8 *b*.

Some of the teeth of one other species of reptile allied to the Crocodiles was found in company with the preceding, but which differ from the described forms in having the whole surface covered with well defined longitudinal flutings extending from the base to the apex—similar to those of Mosasaurus; but the tooth is without an enlarged base.

The precise locality from which these Reptilian teeth were obtained, I am unable to state; they were from the tertiary deposits.

Fishes.—Of all the remains found in this locality, those of fishes are by far the most numerous, and of these the largest portion belong to the Plagiostome group, and will therefore be almost necessarily represented by the teeth alone. As nearly all the genera and species have been previously described, a catalogue of them will be all that is necessary.

Lamna compressa, Agass.

L. acuminata, Agass.

L. crassidens, Agass.

L. elegans, Agass.

All of these have been found in the Eocene beds of S. Carolina by Dr. R. W. Gibbes. The specimens above enumerated were

found in digging wells in Richmond, but whether from Eocene or Miocene beds I am unable to state.

Otodus appendiculatus, Agass.
O. lineatus.
O. obliquus, Agass.
O. lanceolatus.
Oxyrhina hastalis, Agass.
Ox. xiphodon, Agass.
Hemipristis serra, Agass.
Carcharodon angustidens, Agass.
Galeocerdo contortus, Gibbes.
G. Egertonii, Agass.
Sphyrna lata, Agass.
Glyphis subulata, Gibbes.

Notidanus primigenius. This species is quite rare. The specimen here referred to is the only one which I have seen mentioned as coming from the U. States. This was described by Dr. R. W. Gibbes in his memoir on the fossil Squalidæ *

Genus Myliobatis.—After the genus Lamna, Myliobatis may be mentioned as the one which furnishes the largest number of remains.

Genus Phyllodus.—The palatine or pharyngeal plates, fig. 9 *a* and *b*, were found by Dr. Burton, and as I believe as far as any record appears to the contrary for the first time in the U. States. Of this remarkable genus first described by Agassiz, nothing has yet been discovered but the plates similar to those represented by the figures. Each of the central plates consists of a series of superimposed layers. Agassiz† and Owen‡ have given the details of their microscopic structure. All the species enumerated by Agassiz, six in number, were found in the London clay of Sheppey. Fig. 9 *a* resembles P. toliapicus. Fig. 9 *b* does not resemble any of the species figured in the Poissons Fossiles, but is imperfect. Owen regards Phyllodus as allied to Scarus, but Agassiz does not admit the correctness of this opinion.

Genus Fogonias.—The peculiar pharyngeal teeth of these fishes have been several times discovered, and I have recently received from Dr. Burton broken specimens of large size.

Vertebræ of fishes.—These exist in great numbers, but almost invariably disjointed. I have no means of determining them. Some few have the elongated bodies of the Scomberoids.

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* Nearly all the names given above were furnished me by Dr. Gibbes. For a full description of the genera and species here enumerated, his valuable memoir can be referred to as containing the most complete description as yet given of the fossil Squalidæ the U. States. See his Memoir, Jour. Acad. Nat. Sciences, Philadelphia, 1849.

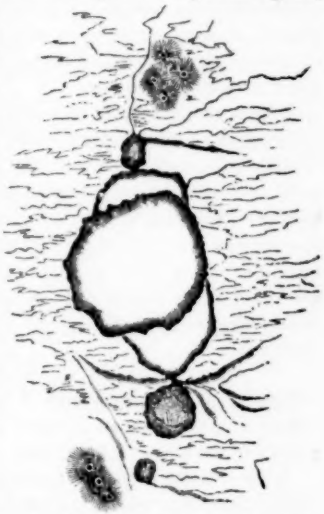
† Poissons Fossiles, t. ii, p 238.

‡ Odontography.

Coprolites.—Of numerous specimens of these remains, there is one of unusual dimensions. It is six and a half inches in length and three inches in diameter. It presents indications of having been moulded upon a spiral membrane; its fractured surface exhibits fragments of bone and something resembling the scales of fishes. The color of the fractured surface is of a reddish brown.

ART. XXII.—*On the Volcanic Eruptions of Hawaii;* by JAMES D. DANA—.Continued from vol. ix, p. 364.

IN a former article, a historical account was given of the eruptions of Kilauea, the great pit-crater on the flanks of Mount Loa, situated at a height of about 4000 feet above the sea. The following pages contain what information we have collected respecting the summit eruptions of Mount Loa.* The crater is a deep pit in the very summit of the mountain dome, and is called by the natives Mokua-weo-weo.† It has nearly an elliptical figure, as shown in the annexed cut, with its diameters 13,000 and 8000 feet respectively, the longer lying in a north-by-west and south-by-east direction. But the deep part of the crater is nearly circular, and has the breadth of the smaller diameter, the northern and southern portions being shallow. The walls, through a considerable portion of their circuit, are abrupt or even vertical, and are stratified in structure like the sides of Kilauea; on the west side the height was found by Henry Eld, Jr., to be seven hundred and eighty-four feet, and on the east four hundred and seventy feet.



The bottom of the pit when examined by Captain Wilkes and the officers of the Vincennes, consisted of solidified lava, through which there were several fissures and fumaroles emitting steam and sulphur vapors in large volumes. Some parts were rough

* The summit crater was examined and thoroughly explored by Captain Wilkes and the officers of the Vincennes, and a detailed account of it is given in the fourth volume of the Narrative of the Expedition. The above sketch is a reduced copy of that in the Narrative, p. 111. The author's explorations did not reach above Kilauea, his time having been limited by orders to other groups of Islands.

† The name of the crater is pronounced *Mokooah-wayo-wayo.*

with clinkers, while in others, smoother tracts of solid lava constituted the surface. The fissures had in general a north-northwest and south-southeast direction, and one near the west bank had ejected lavas at no distant period. Two cinder cones at the bottom, consisting of light scoria, were remarkably perfect in form, and one was two hundred feet high. About many of the fumaroles there were the same salts that occur at the sulphur banks of Kilauea.

Besides the large pit there were two others, one on the north, and another (called Pohakuo-hanalei) on the south, both of which may be looked upon as subordinate to the central crater, as they are enclosed within the same general rim or outline. There is also another small pit, distinct from these, a short distance to the south.

Into Pohakuo-hanalei, a stream of lava had run from Mokua-weo-weo, and Capt. Wilkes remarks that it looked like a cascade of iron which had become solid before reaching the bottom. There were several deep fissures in the vicinity of this pit, and every appearance of recent eruptions. "The lava at the mouth of some of the chasms appeared as though it had been thrown up and plastered on the edges in clots, which seemed of the consistency of tar or melted sealing-wax of various colors, the most predominant a dark brown."

There were several small cones about the summit, both to the north and south of Mokua-weo-weo.

The rocks of the summit, where there was evidence in their appearance of recent origin, resembled those of modern ejections below. But the walls of the crater are described as consisting of a compact grayish rock without cellules and often breaking in plates. The specimens obtained were a grayish clinkstone speckled with a white feldspar, with no trace of a cellule, and no resemblance to ordinary lavas. They consisted mostly of the feldspar.

But little is known with regard to the eruptions of the summit crater. Yet there is abundant evidence that, even at the present time, its fires are not entirely inactive.

An eruption is stated to have taken place on the 20th of June, 1832, and the mountain continued burning for two or three weeks; the lavas broke out, in different places, and were discharged from so many vents, that the fires were seen on every side of the dome, and were visible as far as Lahaina, upwards of one hundred miles.*

The first ascent to the summit of Mount Loa by a foreigner was made by Dr. Douglass. This author describes it as far sur-

* See this Journal, volume xxv, 201, in a communication from Rev. J. Goodrich, dated Nov. 17, 1832.

passing Kilauea in sublimity and violent activity. Mr. Douglass's observations are, however, received with incredulity by the residents. The crater, if thus active, would, like Kilauea, have shown evidence of it in an illuminated cloud at night. But neither this nor any other proofs of its action were noticed at the time by the Hawaiians or by the whites residing among them.*

An eruption took place in January, 1843, which is described by Messrs. Andrews and Coan.† It broke out at the summit, on the 10th of January, and continued down the slopes of Mount Loa in two streams; one flowed to the westward towards Kona; the other flowed northward to the foot of Mount Kea, and then dividing, one part continued on towards Waimea northeastward, and the other towards Hilo, eastward.

We cite here the account given by the Rev. Mr. Coan of the American Mission at Hilo on the eastern shore, who has spent much time in his many explorations of Mount Loa.

"On the morning of January 10th, before day, we discovered a small beacon fire near the summit of Mauna Loa, directly in the rear of our station, about thirty miles distant. This was soon found to be a new volcano, bursting out on the northeastern slope of the mountain, at an elevation of near 13,000 feet. From this time, the eruption increased in magnitude and intensity, from day to day, till it presented a scene of sublime splendor, disgorging vast columns of fiery fluid which rolled in a broad, burning river down the side of the mountain. Subsequently the lava appeared to burst out at several different points lower down the mountain, from whence it flowed off in the direction of Mauna Kea, filling the great valley between the mountains with a sea of fire, and throwing a broad sheen of light upon the heavens. Some of our nights have presented scenes sublimely grand and fearfully magnificent. The position of the eruption is such that it can be distinctly seen from the window of our

* A comparison of the statements in the following paragraph by Mr. Douglass, with the observations by the officers of the Vincennes, will show that this incredulity is probably not misplaced. "The mountain (Mount Loa), with an elevation of 13,517 feet, is one of the most interesting in the world. The journey to the top took me seventeen days. On the summit is a volcano, nearly twenty-four (?) miles in circumference, and at present in terrific activity. You must not confound this with the one situated on the flanks of Mauna Roa, and spoken of by the missionaries and Lord Byron, and which I visited also. It is difficult to attempt describing such an immense place. The spectator is lost in terror and admiration at beholding an enormous sunken pit, (for it differs from all our notions of volcanoes as possessing cone-shaped summits with terminal openings,) five miles square of which is a lake of liquid fire, in a state of ebullition, sometimes tranquil, at other times rolling its blazing waves with furious agitation, and casting them upwards in columns from thirty to one hundred and seventy feet. This volcano is 1272 feet deep; I mean down to the surface of the fire; its chasms and caverns can never be measured." Extracts from the Journal of Mr. Douglass, Magazine of Zoology and Botany, 1837, i, 582.

† Missionary Herald, xxxix, 381, 463; and xl, 44. The course of the stream, and its origin were particularly examined by the Rev. T. Coan.

dormitory, so that we can lie on our couch and watch the fantastic and ever varying action of the fires from evening to morning. The rapid disgorgement of the gory flood, the lofty rising of brilliant pillars—like burning brass—the irregular shooting of coruscations, and the fearful flow of the molten sea—all tend to excite a wakeful spirit, and incline us sometimes to keep vigils for most of the night. For about four weeks, this scene continued without much abatement. At the present time, after six weeks, the action of the fire is greatly diminished, though it is still somewhat vehement at one or two points along the line of eruption. The flow of the lava has probably extended twenty miles. As to its breadth and depth, we can form no opinion at this distance. We apprehend that the fires have nearly spent their force, though in this we may be mistaken."

[On Monday the 6th of March, Mr. Coan, in company with Mr. Paris and seven natives, left Hilo on their tour of exploration.]

"We did not take the usual route—that pursued by Captain Wilkes and others, via Kilauea—but directed our course at once for the stream of lava, as it was seen flowing on the high plains between Mauna Loa and Mauna Kea. Our general course was west-south-west, through a vast forest, so interwoven with jungle as to render it in most places impenetrable. As the season was peculiarly dry, we chose for our path the rocky bed of a river, called the River of Destruction, from the quantity and rush of its waters during the rainy seasons. The stream was now so low that we could pass up its bed and under its banks by leaping from rock to rock, and frequently crossing from side to side, now and then also ascending its banks and beating our way for a short distance through the brushwood, to avoid deep water, perpendicular precipices, or the accumulated masses of drift-wood. These drift wood accumulations consisted often of majestic trees which had been torn violently from their places, and, with roots, trunk, and branches, carried down the stream to some narrow pass, where their progress was arrested by the approaching banks, by vast rocks, or by a sudden bend in the stream, so as to form an impregnable chevaux-de-frise against the traveller.

[The night was spent by Mr. Coan and his party in the outskirts of the forest already mentioned.]

On the second day, we again entered the bed of the stream, and pursued our romantic course along the serpentine and rocky channel, and between its precipitous and often overhanging banks, which sometimes presented frowning battlements of dark naked lava, and sometimes retreated in graceful slopes of luxuriant soil, adorned with trees, shrubs, vines, and parasitical plants, or spread with a splendid carpet of soft velvet moss. In this lofty and deep forest, and amid these everlasting solitudes—unbroken except by the gurgling of the wasted stream, the dashing of the

cascade, or the mighty rush and the deep thunder tones of the mountain torrent, and, I should add, by the enchanting strains of the ten thousand songsters whose notes seemed to fill every leaf and shrub and tree with animated joy—we pursued our quiet way till the outstretching shades of evening admonished us to prepare for repose.

[The night was passed in a booth of boughs and ferns, erected for the emergency on the bank of the river.]

Early the next morning, we pursued our way up the stream, and at noon found ourselves fairly out of the forest with the lofty summit of Mauna Kea rising in hoary grandeur before us. We were now at its base, and in the high, open country occupied by herds of wild cattle. We bent our course south-south-west, over a beautiful rolling country, sprinkled here and there with clumps of low, spreading trees, which looked like orchards in the distance. Our way was along the upper skirts of the forest, having Mauna Kea with its numerous peaks and lateral craters on our right. At evening we came in full view of Mauna Loa, bearing south by west from us. We pitched our tent under an ancient crater, four hundred feet high, now covered with trees and grass.

Here we had a splendid view of the great terminal crater on the summit of the mountain, about twenty-five miles distant, and also of the vast flood of lava which had flowed down the northern side of the mountain to the plains below, some part of which lay burning at our feet, at the distance of four or five miles. We were now seven or eight thousand feet above the level of the sea; and we could see the dark clouds gather, and the lightnings blaze below us, while the deep toned thunder rolled at our feet. At the same time, a storm of hail spread along the shore and fell upon the station at Hilo. This was the first hail seen at our station since our arrival at the Islands. At twilight a smart shock of an earthquake, which lasted thirty seconds, added to the sublimity of the scene; while a blazing comet hung over us in the vaulted sky. As darkness gathered around us, the lurid fires of the volcano began to glow with fervid heat, and to gleam upon us from the foot of Mauna Kea, over all the plain between the two mountains, and up the side of Mauna Loa to its snow-crowned summit, exhibiting the appearance of vast and innumerable furnaces, burning with intense vehemence, and throwing out a terrible radiance in all directions. During the night we had thunder and lightning; and in the morning both mountains were beautifully mantled in snow.

It was now Thursday, and we left our encampment and proceeded three or four miles towards the new stream of lava, and again pitched our tent on the side of an old crater, two hundred feet high and one mile in circumference, and covered with trees

and shrubbery to its summit. It was surrounded at its base, however, by a vast field of naked scoria of the most jagged character, the deposit of some former eruption which had flowed around the little fertile hill, and left it like an island in the ocean, or like an oasis in the desert. Leaving our natives to prepare our encampment and collect fuel, water, etc., we set off for the nearest stream of active lava, distant about two miles. Our road was over sharp jagged lava, thrown up in tumultuous confusion; but we soon made our way to the molten stream, and, thrusting our staffs into the viscid mass, took out and cooled specimens which we carried home with us. You will understand that we were now on the great plain between Mauna Loa and Mauna Kea, about 7,000 feet above the level of the sea, not having as yet commenced the direct ascent of the mountain. On this plain, between the bases of the two mountains, we spent the day in traversing and surveying the immense streams of fresh scoria and slag, which lay smouldering in wild confusion farther than the eye could reach,—some cooled, some half-cooled, and some still in a state of igneous fusion. The scoriform masses which formed the larger portion of the flowings, lay piled in mounds and extended in high ridges of from thirty to sixty feet elevation above the substratum on which it rested, and forming a barrier so indescribably jagged and rough as to be nearly impassable. It seemed as if this vast sea of earthy and rocky fusion had been suddenly solidified, while in a state of the most tumultuous action. Besides these high and broad ridges of scoria, there were parallel streams of slag, solidified on the top, like ice on a river. This was smooth, of lustrous black, and in a vitrescent state, forming the superincumbent crust of a deep molten river which rolled beneath, and which betrayed its burning course at innumerable cracks and seams and blow-holes, in which the fiery fluid was seen, or through which it was expelled in gory jets.

We spent the whole day in exploring this vast sea of lava, and were astonished at its immense area. In rolling down the side of the mountain, one broad stream had shot off in a westerly direction, towards Kona. Another mighty river had flowed northward till it was intercepted by the base of Mauna Kea, when it divided into two branches, one flowing in a north-west direction towards the plains of Waimea, and the other arm stretching north-east and flowing towards Hilo. These three main branches, if united, would form probably a river five or six miles broad; and the longest of them cannot I think, have advanced less than twenty-five or thirty miles. They are still flowing, but their progress at present is slow, as they are on a vast plain, and their celerity is also retarded by fissures and caverns, and by fields of old scoria which covers those high regions. Should the eruption continue, and should the quantity of fusion be sufficient to overcome the obstacles and reach the

regions where the face of the country declines rapidly towards the sea, the descent will then be quick and easy to the coast, both on the eastern and western shores. This may take place though I am rather of the opinion that the fires will have spent their force before they reach the sea.

Besides the three great branches described, there are numerous smaller ones, shooting out laterally and irregularly from the main streams, both on the side and at the base of the mountain. These form together an indescribable labyrinth.

After travelling hard all day, without being able to reach the extreme ends of the two great western branches of the eruption, we returned at evening to our tent, weary, but gratified nearly to oppression by the vastness and the terribleness of the scenes we had witnessed.

[During the night, a dense, dark cloud invested the eminence on which the travellers had encamped; this was charged with electric fluid, which soon began to blaze around them with terrific splendor, accompanied, at the same time, with startling peals of thunder. They felt that they were "in a sea of electricity;" and realized the sublimity of the expression, "The God of Glory thundereth." At length the storm passed away, and the volcanic fires which had been concealed by the tempest, "resumed their merry dance, spouting forth their gory masses in fantastic and ever varying forms, at different points, from mountain to mountain, along the whole line of eruption."]

Ascent to the Crater.—The next morning we rose early, and made our preparations for visiting the summit of the mountain, distant about twenty miles. As we did not suppose it possible to reach the summit and return to our camp the same day, we provided ourselves with caps, flannels, mittens, cloaks, comfortables, etc., for sleeping upon the lava on the side of the mountain; and taking a little food and a calabash of water, we committed our luggage to two strong natives, leaving the rest of our company where we had encamped during the night. Thus prepared we set off, expecting to spend two days upon the mountain. Our way at first lay over a field of scoria of an indescribably sharp and jagged character; and we had not proceeded more than half a mile before we found that the two natives who carried our clothing fell in the rear, and followed us at the rate of less than a mile an hour,—the road being so inconceivably rugged that they could not quicken their pace without being in danger of stumbling at every step, and breaking their calabashes, and tearing their flesh. We halted suddenly, held a short consultation, set down our calabashes on the lava, took a little biscuit in our pockets, laid our cloaks and umbrellas on our guides, and leaving everything else behind, set out again for the summit of the mountain. After passing this tract of scoria, we came to a field of

more compact and smooth lava, lying along the borders of the new stream. Here we moved on rapidly, at the rate of three and a half or four miles an hour. As we had left most of our clothing and food, with all our water, behind, and as we clung to the hope of reaching the original point of eruption—a vast, active crater, within a few hundred feet of the highest part of the mountain—we felt it necessary to press hard and improve every moment, as we must return the same day, or probably perish with cold amid those high regions of snow and tempests.

To describe our road would be tedious, if not impossible. Sometimes we were on ancient deposits and sometimes on the new; sometimes on broad fields of smooth, shining lava, and sometimes crossing extended tracts of the sharp, spurry kind before mentioned; now we were climbing a high ridge of loose scoria and slag, and then feeling our way down a ravine amidst poised and pendant masses that seemed to say, "Touch us not lest we bury you from the light of day."

At ten o'clock we were fairly at the foot of the mountain proper, and began a more regular and rapid ascent, though we had been gradually rising for an hour or two before. The new streams of lava, spread to the breadth of several miles over the side of the mountain, for the most part were nearly cooled; in many places, however, they were burning hot, and emitting smoke, steam, and pungent gases.

At noon we lost sight of our native attendants, who were unable to keep up with us in our rapid and forced march, and we saw them no more during the day. We were now on the new eruption, and our ascent became more and more steep; while the rarity of the atmosphere affected our respiration, so that it was difficult to proceed many rods without stopping to pant and recover breath. The lava on which we were treading gave indubitable evidence of powerful igneous action below, as it was hot and full of seams, from which smoke and gas were escaping. But we soon had ocular demonstration of what was the state beneath us; for in passing along we came to an opening in the superincumbent stratum, of twenty yards long and ten wide, through which we looked, and at the depth of fifty feet, we saw a vast tunnel or subterranean canal, lined with smooth vitrified matter, and forming the channel of a river of fire. which swept down the steep side of the mountain with amazing velocity. The sight of this covered aqueduct—or if I may be allowed to coin a word, this *pyroduct*—filled with mineral fusion, and flowing under our feet at the rate of twenty miles an hour, was truly startling. One glance at the fearful spectacle was worth a journey of a thousand miles. We gazed upon the scene with a kind of ecstasy, knowing that we had been travelling for hours over this river of fire, and crossing and recrossing it at numerous points. As we passed up the

mountain, we found several similar openings into this canal, through which we cast large stones; these instead of sinking into the viscid mass, were borne instantly out of our sight upon its burning bosom. Mounds, ridges, and cones were also thrown up along the line of the lava stream, from the latter of which, steam, gases, and hot stones, were ejected into the air with terrible hissings and belchings.

We had proposed to commence our return at one o'clock in the afternoon; but the hour came and we were still far from the summit. We then added half an hour to the ascent. This passed, but we had not reached the end of our journey. We went on adding half hour to half hour till three o'clock, at which time we reached the verge of the great crater where the eruption first took place, near the highest point of the mountain. This was in the region of perpetual snow; and to reach it we had passed through snow for the last three miles. Here we found two immense craters close to each other, of vast depth and in terrific action; but we had not a moment left to stay and survey them minutely. Kneeling, therefore, among these awful scenes to bless the Hand which had led us thus far, and to ask protection on our return, we turned our faces down the mountain.

Though weary and way-worn, almost to the last degree, we felt that we must regain our tent, long lost in the distance, or run the hazard of perishing upon the mountain. We ran, walked, clambered, descended, stumbled, feeling unable at every step to drag one foot after the other, and yet necessity impelled us to proceed. At length night came on; we were still in a trackless waste of frowning lava, not less than eight or ten miles from our camp. But by the cheering aid of a moon in her first quarter, we could still trace the distant outlines of the green hill on which our cottage of branches stood. We plodded on, alternately walking and resting, at rapid intervals, until a fog came on us shutting out at once the hill, the heavens, and even the volcanic fire from our sight. We could not now keep our course, as we could not see our compass. We wandered some, but not far from the track. Still there was little hope that we should reach our camp.

In about an hour, however, the fog dispersed, the moon and stars looked benignantly upon us, and the volcanic fires began again to play on our left; and after persevering toil, with indescribable weariness, we reached our tent a few minutes before eleven at night. I need not say that our thirsty, exhausted, and lacerated frames welcomed rest and refreshment; nor that our thankful spirits felt untold satisfaction in view of the wondrous scenes we had witnessed during this laborious and eventful day."

[On the following morning, Messrs. Coan and Paris, with the natives who accompanied them, set out upon their return to Hilo.]

In a letter subsequently received by the author from Mr. Coan he states:—"The angle of descent down which the lavas flowed from the summit to the northern base of Mauna Loa is 6°; but there are many places on the side of the mountain where the inclination is 10°, 15°, or 25°, and even down these local declivities of half a mile to two miles in extent, the lava flowed in a continuous stream. This was the fact not only during the flow of several weeks upon the surface, but also in that wonderful flow in the subterranean duct, described in the Missionary Herald. There was no insurmountable barrier in the way of the flow from the summit of Mauna Loa to the base of Mauna Kea, a distance of twenty-five or thirty miles. The stream sometimes struck mounds or hillocks, which changed its course for a little space, or around which it flowed in two channels, reuniting on the lower side of the obstacle, and thus surrounding and leaving it an island in the fiery stream. Ravines, caves, valleys, and depressions were filled up by the lava as it passed down the slope of the mountain, and between the two mountains. In conclusion, I remark, that the stream was continuous for more than twenty-five miles, with an average breadth of one and a half miles, and flowed down a declivity varying from 25° to 1°."

The quiet character of the eruptions of Kilauea was remarked upon in a former article. It is still more surprising that an outbreak of such magnitude as that just described should have taken place, without warning to the islanders.—From a height of 14,000 feet, lavas break out, in a copious flow, and for 25 miles there is a rending of the mountain, and continued ejections; and yet there are none of the terrible convulsions and heavings and darkening showers of ashes or cinders that accompany the eruptions of many smaller volcanoes: there is not even a grumbling beneath to suggest alarm; the first indication was the discovery of what appeared to be a small "beacon fire" near the summit of the dome.

During all this time, Kilauea, on the flanks of the mountain at a level 10,000 feet below, was in its usual active condition, and as an observer says, it showed not the least signs of sympathy. The crater is an opening 3½ miles in length; and within it, an area 1500 and 1000 feet in its diameters, was at the time in constant undisturbed ebullition.

Since 1843, there has been another eruption from the summit, and we look for an early account from the island to give our readers. It took place the past year, and was as remarkable as that described for its quietness of progress, and its extent.

Art. XXIII.—*Mineralogical Notices.**

I. New Species.

1. **Tritomite**, (S. H. Weibye and N. J. Berlin, Pogg., lxxix, 299, 1850.)—Crystals tetrahedral; surfaces smooth and having a reddish crust; cleavage indistinct. Lustre submetallic vitreous. Color dull brown; streak dirty yellowish-gray. Translucent only on the edges. H. between feldspar and apatite. G. = 4·16—4·66. B.B. becomes white, intumesces somewhat, and sometimes decrepitates. In a matrass yields water and gives a weak fluorine reaction. With borax dissolves to a reddish yellow glass, which is colorless on cooling. With muriatic acid, when pulverized, yields chlorine and gelatinizes. *Composition* according to N. J. Berlin, (specific gravity of specimen, 4·24.)

Si	Al	Ce	La	Y	Ca	Mg	Fe	Na	Mn, Cu, Sn, W,
20·13	2·24	40·36	15·11	0·46	5·15	0·22	1·83	1·46	4·62

loss by ignition 7·86=99·44.

The production of chlorine on heating with muriatic acid shows that the mineral contains the cerium either wholly or in part, as peroxyd. The mineral appears therefore to be a hydrous silicate of the peroxyds of cerium and lanthanum and of lime.

This mineral is from the island of Lamö near Brevig in Norway, and occurs with leucophane and mosandrite in a coarse syenite.

2. **Catapleiite**, (Weibye and Sjögren, ibid.)—Probably monoclinic; found only in imperfect prismatic crystals of 120° nearly, showing sometimes traces of other vertical faces. Cleavage basal, perfect. Surfaces smooth, with little lustre; on fracture, weak vitreous. Color light yellowish brown. Streak isabella-yellow. Opaque. H. near that of feldspar; G. = 2·8. B.B. in the platinum forceps fuses easily to a white enamel; with borax dissolves with difficulty to a clear colorless glass; cobalt solution colored blue. Dissolves easily in muriatic acid, when pulverized, without gelatinizing. Composition according to Sjögren:—

	Si	Zr	Al	Na	Ca	Fe	H
1	46·83	29·81	0·45	10·83	3·61	0·63	8·86
2	46·52	29·33	1·40	10·06	4·66	0·49	9·05
Oxygen,	24·15	7·72	0·65	2·58	1·33	0·11	8·04

* In the writer's treatise on Mineralogy (third edition), which left the press in May last, the science of Minerals is posted up, as far as could be done in this country, to the time of its publication. The author proposes to continue his appendix to that work in this Journal, giving in each volume an abstract of all the mineral information which has been received through the different foreign and American publications. J. D. D.

Whence for the protoxyds, peroxyds, silica and water, 4·02 : 8·37 : 24·15 : 8·04 = 1 : 2 : 6 : 2, giving the formula

$$3(\dot{Na}, \dot{Ca})\,\ddot{Si} + \ddot{Zr}^3\,\ddot{Si}^2 + 6\dot{H}.$$

The earth called zirconia was proved to be identical with the zirconia of the Fredericksvärn zircon. Whether it may not be the allied earth Noria, it is at present difficult to determine.

This mineral is associated with the Tritomite.

3. Atheriastite, (Weibye and Berlin, ibid.)—Dimetric. In square or eight sided prisms terminating in a pyramid having the terminal angle 135°. Cleavage lateral, perfect, surfaces even and smooth, but not shining. Color verdigris-green, commonly somewhat dirty; streak greenish-gray. Opaque. Fracture uneven and splintery. B.B. in the forceps intumesces, and fuses easily to a dull brown glass. In fine powder slightly decomposed in muriatic acid. Composition according to Berlin:—

	$\ddot{Si}$	$\ddot{Al}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{H}$
	38·00	24·10	22·64	2·80	4·82	0·78	6·95
Oxygen,	19·73	11·25	6·47	1·10	1·07	0·17	6·22

This gives for the oxygen of the protoxyds, peroxyds, silica and water, 8·81 : 11·25 : 19·73 : 6·22, whence the author deduces the formula $4\dot{R}^3\,\ddot{Si} + 5\ddot{Al}\,\ddot{Si} + 9\dot{H}$, or, as more probable, $2\dot{R}^3\,\ddot{Si} + 3\ddot{Al}\,\ddot{Si} + 4\dot{H}$. From an iron mine near Arendal, in granite with black garnet and Keilhauite. It had been taken for scapolite. [Is it not still possible that the mineral may be an *altered* scapolite? The angle of the pyramid of scapolite is 136°, which is very near that given for the Atheriastite.]

4. Eudnophite, (Weibye, von Borck, and Berlin, ibid.)—Trimetric. Crystals rhombic prisms of about 130°; $o : d = 130°$ *. Cleavage, basal perfect; diagonals less perfect. Cleavage face somewhat pearly. Also granular massive, and sometimes having a feathery arrangement. Color white, to gray or brown. Subtranslucent to translucent. H. = 5·5. G. = 2·27. B.B. fuses to a clear colorless glass. Pulverized forms a jelly with muriatic acid. Composition according to von Borck and Berlin:—

	$\ddot{Si}$	$\ddot{Al}$	$\dot{Na}$	$\dot{H}$
1	54·93	25·59	14·06	8·29 = 100·87
2	55·06	23·12	14·06	8·16 = 100·41

This gives the formula of analcime, $\dot{Na}^3\,\ddot{Si}^2 + 3\ddot{Al}\,\ddot{Si}^2 + 6\dot{H}$, and the compound is therefore dimorphous. Found with leucophane on the island of Lamö, Norway, in syenite.

* The angle between d and s is given at 120°; and if this be right the vertical prism ($d : d$) must also have an angle of 120°.—D.

5. DILLNITE, *associated with Diaspore*, (A. Hutzelmann, cited in Pogg., lxxviii, 575, from the Bulletin of the Freunden der Naturwiss. in Vienna.)—There are three substances forming together the gangue of the diaspore of Schemnitz:—One (*A*) is gray, slightly greenish, with a weak greasy lustre and faint translucence; H.=2·5–3·0; G.=2·735. A second (*B*) is white, opaque, with an even and flat conchoidal fracture, and firm; H.=3·5; G.=2·835. Adheres a little to the tongue. A third (*C*) is white, opaque, earthy; H.=1·8—2·0; G.=2·574. Adheres strongly to the tongue. The first and third have been analyzed by Karafiat, the second by Hutzelmann, as follows:

	$\ddot{S}i$	$\dot{A}l$	$\dot{C}a$	$\dot{M}g$	$\dot{F}e$	$\dot{M}n$	$\dot{K}$ & $\dot{N}a$	$\dot{H}$	
A.	49·50	27·45	5·56	0·72	1·03	*trace*	10·20	5·10	= 99·56
B.	22·40	56·40	*trace*	0·44	*trace*	*trace*	*trace*	21·13	=100·37
C.	23·53	53·00	0·88	1·76	——	——	——	20·05	= 99·22

Excluding the magnesia and reducing to a per-centage, B and C become

	$\ddot{S}i$	$\dot{A}l$	$\dot{H}$
B.	22·41	56·45	21·14
C.	24·36	54·88	20·76

The first (*A*) is near agalmatolite, whose formula is

$$\dot{K}\,\ddot{S}i+2\dot{A}l^2\,\ddot{S}i^3+3\dot{H}.$$

The other two are probably identical, and to these the name *Dillnite* is applied. Haidinger deduces the formula $\dot{A}l^2\,\ddot{S}i+4\dot{H}$= Silica 24·97, alumina 55·56, water 19·47; and this he observes may be resolved into $\dot{A}l\,\ddot{S}i+2\dot{H}$, the formula of nacrite and much kaolin, and $\dot{A}l\,\dot{H}^2$, a hydrated alumina. [The formula $\dot{A}l^2\,\ddot{S}i+4\frac{1}{2}\dot{H}$ is still nearer C, giving silica 24·39, alumina 54·23, water 21·38.]

The diaspore of this locality has the specific gravity 3·340.

6. BRONGNIARDITE, (M. A. Damour, Ann. des Mines, [4], xvi, 227.)—Brongniardite is an ore of antimony, lead and silver, from the mines of Mexico, whence it was brought by M. de Castelnau. The specimen was a compact mass weighing about 15½ pounds, and having one surface sprinkled with pyrites. The following are its characters:—Massive, without cleavage. Lustre metallic, resembling that of polybasite or bournonite. Streak-powder grayish-black. Hardness above that of calcite, but scratched by a point of iron. Specific gravity at 18° C., 5·950.

B.B. on charcoal, decrepitates, fuses easily at a temperature below red heat, giving off an odor of sulphur and white vapors. After roasting, it yields a globule of silver, surrounded with a yellow areola of oxyd of lead. In a closed tube, decrepitates, fuses and affords a feeble sublimate of a reddish orange color, surmounted by a white sublimate. In an open tube decrepitates, fuses, and affords an odor of sulphur, and a white sublimate of peroxyd of antimony covers the walls of the tube. Rapidly attacked by concentric nitric acid, disengaging nitrous vapors and

depositing sulphur, oxyd of antimony and sulphate of lead. With dilute acid there is a slow action yielding vapors of sulphuretted hydrogen; the silver and lead are partially dissolved, and there is a gray deposit in small needles of sulphuret and oxyd of antimony retaining a notable proportion of lead and silver. Attacked also by chlorohydric acid, and when pulverized by a boiling lye of caustic potash. Composition:—

	S	Sb	Ag	Pb	Cu	Fe	Zn	
1.	19·38	29·95	25·03	24·74	0·54	0·30	0·40	= 100·34
2.	19·21	29·60	24·46	25·05	0·61	0·26	0·32	= 99·51
3.	19·14	29·75	24·81	24·94	0·70	0·22	0·37	= 99·93

The result gives the formula $PbS+AgS+SbS^3$ [equivalent to $2(Pb, Ag)S+SbS^3$,] = Sulphur 19·08, antimony 30·66, silver 25·65, lead 24·61 = 100.

M. Damour observes that the composition approaches most nearly that of the Schilfglaserz (Freislebenite), the mean of two analyses of which by Wöhler, is, S 18·74, Sb 27·38, Ag 22·93, Pb 30·27 = 99·32.

[The formula is identical in general character with that of feather ore (heteromorphite of Rammelsberg), it differing only in having half the lead replaced by silver. Wöhler's formula for the Freislebenite corresponds to $7(Pb, Ag)S+3SbS^3$ or $2\frac{1}{3}(Pb, Ag)S+SbS^3$, the silver and lead being in the proportions of 3 to 4.*]

II. Described Species.

Dolomite from the Muschelkalk near Saarbrücken, (R. Wildenstein, J. für prakt. Chem., xlix, 154, 1850.)—This dolomite is crystalline granular, and yellowish gray in color. G. = 2·753. Composition according to Wildenstein:—

$\dot{C}$ 46·30 $\dot{C}a$ 30·50 $\dot{M}g$ 20·13 $\dot{F}e$ 1·17 $\dot{K}$ trace, Clay and sand 1·88 = 99·98

or $\dot{C}a\,\dot{C}$ 54·47, $\dot{M}g\,\dot{C}$ 41·62, $\dot{F}e\,\dot{C}$ 1·88, $\dot{K}$ trace, Clay and sand 1·88 = 99·85

Dolomite from the zinc mines of Altenberg near Aix la Chapelle, (K. Monheim, cited by J. f. pr. Chem., xlix, 318, from Verhandl. des nat. Vereines der preuss. Rheinlande, v., 41.)—Composition:—

$\dot{C}a\,\dot{C}$ 54·31, $\dot{M}g\,\dot{C}$ 43·26, $\dot{Z}n\,\dot{C}$ 1·38, $\dot{F}e\,\dot{C}$ 0·99, $\dot{M}n\,\dot{C}$ 0·56, $\ddot{S}i$ 0·48 = 100·98,

corresponding to equal equivalents of carbonate of lime and carbonate of the other bases.

Green Spathic Iron from near the zinc mines of Altenberg, (K. Monheim, ibid, xlix, 318, from the same.)—The crystals have the specific gravity 3·60. Composition according to Monheim:—

$\dot{F}e\,\dot{C}$ 64·04, $\dot{M}n\,\dot{C}$ 16·56 $\dot{C}a\,\dot{C}$ 20·22 $\ddot{S}i$ 1·10 = 101·92,

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* $9(Pb, Ag)S+4SbS^3$ or $2\frac{1}{4}(Pb, Ag)S+SbS^3$ is even nearer the analysis of freislebenite, it giving,

Sulphur 18·65, antimony 28·65, silver 23·13, lead 29·57 = 100.—D.

This corresponds to $8\dot{F}e\,\dot{C}+2\dot{M}n\,\dot{C}+3\dot{C}a\,\dot{C}$. The mineral resembles the kapnite, a calamine containing over 15 per cent. of carbonate of iron (zinkeisenspath, of the Germans).

Electric Calamine from Altenberg, and from Retzbanya, Hungary.—Analyses by K. Monheim, (ibid, xlix, 319, from the same.)

	$\ddot{S}i$	$\dot{Z}n$	$\dot{F}e$	$\dot{C}$	$\dot{H}$	
1. Altenberg, milky cryst.	24·31	65·74	0·43	0·31	7·51	= 98·30
2. " limpid "	25·40	67·05	—	0·31	7·47	=100·23
3. Retzbanya,	25·34	67·02	0·68	0·35	7·58	=100·97

The results sustain the formula deduced by Berzelius, $2\dot{Z}n^3\,\ddot{S}i+3\dot{H}$. Specific gravity of the Altenberg mineral, 3·43, 3·45, 3·47, 3·49.

Manganesian Calamine.—Analyses by K. Monheim, (ibid, xlix, 382, from the same); 1, from Herrenberge near Riom, in pale green rhombohedrons; G.=4·03. 2, ibid, dull green, G.=2·98. 3, from Altenberg, G.=4·20.

	$\dot{Z}n\,\dot{C}$	$\dot{M}n\,\dot{C}$	$\dot{F}e\,\dot{C}$	$\dot{M}g\,\dot{C}$	$\dot{C}a\,\dot{C}$			
1.	85·78	7·62	2·24	4·44	0·98,	$\ddot{S}i$ 0·09,	$\dot{H}$ *trace*	=101·15
2.	74·42	14·98	3·20	3·38	1·68,	$\ddot{S}i$ 0·20,	$\dot{H}$ 0·56	= 98·12
3.	84·92	6·80	1·58	2·84	1·58,	Electric calamine, 1·85		= 99·57

Nontronite from Andreasberg.—Composition according to Mehner, (J. f. pr. Ch., xlix, 382, from Trommsdorff's J., xii, 27, 1826):

$\ddot{S}i$	$\dot{F}e$	$\ddot{A}l$	$\dot{C}a$	$\dot{F}e$	$\dot{H}$	
40·495	33·705	1·095	1·112	2·259	21·816	=100·482. G.=2·337

Pyrophyllite from Westanâ, (N. J. Berlin, Pogg., lxxviii, 414.)—This pyrophyllite occurs in a quartzose gangue along with micaceous iron ore. G.=2·78—2·79. Analyses by Berlin:—

	$\ddot{S}i$	$\ddot{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{M}n$	$\dot{H}$	
1.	67·77	25·17	0·82	0·66	0·26	0·50	5·82	=101·00
2.	65·61	26·09	0·70	0·69	0·09	0·09	7·08	=100·35
Oxygen,	34·09	12·42					6·29	

In three other trials, the water came out 5·62, 5·77, 7·29. Berlin deduces the formula $\ddot{A}l^2\,\ddot{S}i^5+2\dot{H}$=Silica 65·66, alumina 29·22, water 5·12. The result is very near Rammelsberg's, who suggested the same formula, and also as equally probable, $\ddot{A}l\,\ddot{S}i^3+\dot{H}$= Silica 69·65, alumina 25·73, water 4·62. The composition, as stated by Berlin, is the same with that of an agalmatolite analyzed by Walmstedt; and Rammelsberg remarks upon its approximation to cimolite.

Stilbite of Gustafsberg, Sweden, and Barbro Mine, Norway, (ibid, 415). Analyses by Sjögren:

$\ddot{S}i$	$\ddot{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{H}$	
57·41	16·14	0·25	8·75	16·60	= 99·15
58·41	16·56	——	7·89	16·53, $\dot{M}g$, $\dot{M}n$, alkalies, 0·54	= 99·93

The mineral was dried in powder at 100 C. over sulphuric acid; and in this way, he found the water to correspond with the usual formula, instead of 18 to 19 p. c., as in many other analyses.

Sodalite from the Island Lamö near Brevig in Norway, (Pogg. Ann., lxxviii, 413.) This lavender blue mineral has been mistaken for glaucolite. It occurs in nodular masses in elæolite, and sometimes has a crust of the latter mineral. Composition according to von Borc:—

$\ddot{S}i$	$\dot{A}l$	$\dot{N}a$	$\dot{K}$	$\dot{C}a$	$\dot{M}g$	
38·86	30·82	22·03	0·51	1·21	0·44, with *trace* of Sn, Mn, $\ddot{W}$, $\ddot{M}o$, and chlorine undetermined	=93·87.

A Red Zeolite from near Upsala, Sweden, (N. J. Berlin, Pogg., lxxviii, 415.)—The red zeolite of Upsala resembles that of Ædelfors. The following are analyses; 1, of the Upsala mineral by Sjögren; 2, of that of Ædelfors by Retzius; 3, the same by Hisinger; 4, a similar mineral from Fahlun by Hisinger; and 5, another from Märtenberg by the same.

	$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{H}$	
1.	51·61	19·06	2·96	12·53	14·02	=100·18
2.	60·28	15·42	4·16	8·18	11·07	= 99·11
3.	53·76	18·47	4·02	10·90	11·23	= 98·38
4.	60·00	15·6	1·8	8·0	11·6	= 97·0
5.	53·37	16·50	2·36	13·00	10·67	= 95·90

Berlin deduces for the Upsala mineral, the formula

$$\dot{C}a^3\,\ddot{S}i^2+3\dot{A}l\,\ddot{S}i^2+12\dot{H}$$

=Silica 51·53, alumina 21·49, lime 11·92, water 15·06=100. This is Gerhardt's formula for laumonite.

Berlin suggests that the other minerals may be the same species and that the difference is due to an excess of silica from mixed quartz.

Hyposclerite, (C. Rammelsberg, Pogg., lxxix, 305.)—This mineral from Arendal was named and described by Breithaupt and analyzed by Hermann; the latter obtained the oxygen ratio 1 : 2 : 6 and formula $\dot{R}^3\,\ddot{S}i^2+2\dot{A}l\,\ddot{S}i^2$. Rammelsberg has arrived at a very different result, and for comparison Hermann's analysis is also inserted in this place. G.=2·61, Breithaupt; 2·66, Hermann; 2·63—2·66, Rammelsberg.

	$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{M}n$	$\dot{N}a$	$\dot{K}$	
1. Herm.,	56·43	21·70	0·75	4·83	3·39	0·39	5·79	2·65,	$\dot{C}e$ & $\dot{L}a$ 2, ign.* 1·87=99·80
2. Ramm.,	67·62	16·59	2·30	0·85	1·46	—	10·24	0·51,	ign. 0·69=100·26.

Rammelsberg thus shows that the species is nothing but albite, giving the ratio 1 : 3 : 12, or more exactly 1·25 : 3 : 12·5. Allowing for a small admixture with pyroxene the slight discrepancy that exists is removed.

Castor and Petalite identical, (G. Rose, Pogg., lxxix, 162.)—G. Rose in this memoir shows that castor and petalite are identical in cleavage, hardness and physical characters, corresponding to their close approximation in chemical composition. From a

* The expression *ign.* in this and other places, stands for "loss by ignition."

specimen in the Berlin Royal Museum he obtained the angle 129°, near that given by Breithaupt; but one of the planes (P) was *not* a cleavage plane. The other plane (M) was transversely striated and a second cleavage was found parallel to the striations, which gave with M the angle 141° 32′–141° 35′. This angle is the same observed in petalite, and this was confirmed from specimens by Prof. Rose, who obtained 141° 35 to 142°. Petalite affords in the same zone on the other side of M still a third cleavage (imperfect, however,) which according to Breithaupt forms with M the angle 117°; but this was not detected with certainty in the mineral castor; the largest specimen in hand was but five lines long. The following results show the similarity in composition.

	$\ddot{S}i$	$\dot{A}l$	$\dot{L}i$	$\dot{N}a$	
1. *Petalite*,	77·067	18·000	2·660	2·273	=100. Hagen.
2. *Castor*,	78·012	18·856	$\dot{L}i$ and trace of $\dot{K}$,$\dot{N}a$ 2·760, $\dot{F}e$ 0·613		=100·241, Plattner.

The characters with the blowpipe and acids are also similar.

Manganesian Idocrase, (M. Websky, Pogg., lxxix, 166.)—This idocrase is associated with a mangan-epidote, heteroclin and a fusible mica in quartz, at St. Marcel in Piedmont. The crystals are like those of ordinary idocrase. Color sulphur to honey yellow; streak white. Glass of borax with a small portion of the mineral becomes readily in the oxydation flame of an amethystine color; and in the reduction flame with tin there is a weak iron reaction.

Thulite from the Iron Mine Klodeberg near Arendal, Norway, (N. J. Berlin, Pogg., lxxviii, 414.)—The thulite of this locality resembles rhodonite; it occurs massive, with a splintery fracture and fine rose-red color. G.=3·34. Composition according to Berlin:—

$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{M}n$	$\dddot{Y}$	ign.	
40·28	31·84	1·54	21·42	0·66	0·95	0·22	1·32	=98·23;

the alkali was undetermined. The constitution is that of epidote.

Allanite from Krux near Schmiedefeld in Thüringer-Wald, (H. Credner, of Gotha, Pogg., lxxix, 144.)—The allanite occurs in a coarse granite, and also along with crystals of specular iron, overlaid by calcite and fluor spar, in a bed of magnetic iron ore. It is either massive or crystallized. H.=5½ to 6. G.=3·790, mean of four determinations. Not magnetic. Color jet black, with a faint greenish tinge. Streak and powder greenish-gray, inclining somewhat to brownish yellow. B.B. on charcoal fuses with little intumescence to a black shining globule; with borax, and more distinctly still with salt of phosphorus, gives in either flame a brownish yellow glass which is colorless when cold, and with the latter reagent leaves a silica skeleton. In a matrass yields some water, without changing color. Not decomposed by muriatic acid. Composition according to Credner:—

	$\dot{S}i$	$\dot{A}l$	$\dot{L}a$	$\dot{C}e$	$\dot{Y}$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$	$\dot{H}$	
1.	36·82	16·94	13·32			17·11	0·56	14·84	0·86	0·28	=100·73
2.	37·55	15·99	9·30	3·19	0·56	16·83	0·23	13·60	0·22	1·80	= 99·27

The proportion of silica is larger than in other allanites, and that of oxyds of cerium and lanthanum less. Credner observes that Scheerer obtained the oxygen ratio for protoxyds, peroxyds and silica 2 : 3 : 5, but that his result agrees more nearly with 2 : 3 : 6. [Scheerer's formula for his allanite was $3\dot{R}^3\,\dot{S}i+2\dot{R}\,\dot{S}i$, corresponding to the ratio 3 : 2 : 5. Rammelsberg has since examined the orthite of Hitteroe and obtained the ratio 1 : 1 : 2, by special investigation with respect to the state of oxydation of the bases. If so much of the iron in the first of the preceding analyses be considered peroxyd as will give the ratio 1 : 2 between the oxygen of the alumina and silica, the other bases in the analysis being taken as protoxyd, make very nearly the amount necessary to afford the ratio 1 : 1 : 2; calculation giving for the oxygen 9·30 : 9·56 : 19·13.]

On the Mineralogical and Chemical composition of some Rocks; by M. Delesse, (Ann. des Mines, [4] xvi, 233, 323.)—1. *Quartziferous porphyry;* a, *a variety from Montreuillon, district of Château-Chinon,* containing quartz in small dodecahedral crystals, and lamellar macles of white orthoclase, a little red andesite and a green mica, disseminated through a whitish or greenish white feldspathic paste.—b, *a variety from near Saulieu* (*Cote-d'Or,*) containing grains of hyaline quartz, some orthoclase in reddish lamellar crystals, in a brownish red feldspathic base.

	$\dot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{K}$, $\dot{N}a$, $\dot{M}g$,	ign.	
a.	71·7	15·0	2·9	——	0·4	(diff.) 8·8	1·2	=100
b.	77·5	12·9	2·5	*traces*	0·4	" 6·7	—	=100

2. *Feldspar of a Euphotide;* a, *from Mount Genèvre;* b, *from Odern in the Vosges.*—The feldspar in each case is in lamellar macled crystals of the triclinic system, and has a white or greenish color.

	$\dot{S}i$	$\dot{A}l$	$\dot{M}n$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{N}a$	$\dot{K}$	ign.	
a. (mean)	49·73	29·65	*trace*	0·85	11·18	0·56	4·04	0·24	3·75	=100
b. "	55·23	24·24		$\dot{F}e$ 1·11	6·86	1·48	4·83	3·03	3·05	= 99·83

The specimens were not wholly free from talc and minute veins of serpentine matters. The latter had a neater cleavage than is usual with the feldspar of euphotide, yet was impure also with some carbonate, probably a carbonate of iron, lime and magnesia. Delesse observes that a large proportion of silica and alkalies with less of alumina and lime explains the neater cleavage. He deduces for the $\dot{R}$, $\ddot{R}$ and $\ddot{S}i$ of No. *b*, the oxygen ratio 1 : 3 : 7. It is evident that the feldspar of euphotide differs in species, and is not always labradorite as Boulanger supposed; it sometimes approaches labradorite, sometimes anorthite, and sometimes other varieties of feldspar.

3. *Diallage of the Euphotide of Odern.*—The diallage is in olive green crystalline lamellæ. It fuses before the blowpipe with very great difficulty, much greater than the feldspar associated with it. It afforded

$\ddot{S}i$	$\dot{A}l$	$\ddot{C}r$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$	ign.
49·30	5·50	0·30	9·43	0·51	15·43	17·61	0·85=98·93

Delesse observes that it approaches hornblende, especially that from Nordmark analyzed by Bonsdorff. The chromic acid he believes to be chemically combined in the mineral. He deduces the formula $\dot{R}^3\,\ddot{S}i^2$, which is the formula of the species pyroxene. The oxygen for the protoxyds, peroxyds and silica equals 13·51 : 2·66 : 25·61; and supposing the alumina to replace the silica, the ratio 1 : 2, characteristic of pyroxene, is given. This ratio is more exact when silica and alumina replace one another in the ratio of $3\dot{A}l : 2\ddot{S}i$.

4. *Talc of the Odern Euphotide.*—This talc is in imperfectly radiated translucent lamellæ, often more than a centimetre in length, and constitutes compact masses which cut like a soapstone. Composition :—

$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$ (diff.)	ign.
59·61	0·81	3·95	0·56	2·88	28·41	3·78=100

This result shows, Delesse observes, that it is near that from Little St. Bernard, analyzed by Berthier, and may be represented by the pyroxene formula $\dot{R}^3\,\ddot{S}i^2$.

[The oxygen of the protoxyds and silica equals 12·99 : 30·97 (=1 : 2·38) with 0·38 for that of the alumina. The ratio corresponding is 3 : 7, (the alumina being excluded,) which is equivalent to $\dot{M}g^9\,\ddot{S}i^7$. The ratio 4 : 9 (=1 : 2·25) which differs but little from the result, affords the formula $\dot{M}g^4\,\ddot{S}i^3$, which has been found for other varieties of talc.]

5. *Serpentine of the Euphotide of Odern.*—The serpentine is sometimes in veins as if subsequently filled into fissures, and sometimes in nodules within feldspar, or so graduates into feldspar that it seems to have been formed at the expense of this mineral or of the euphotide as a whole, by a species of metamorphism.

6. *Hornblende of the Diorite of Pont Jean*, valley of the Moselle, near St. Maurice in the Vosges.—This hornblende is fibrous and of a fine green color and forms lamellar masses. G.=3·059. Composition :—

$\ddot{S}i$	$\dot{A}l$	$\ddot{C}r$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$ (diff.)	$\dot{N}a$	$\dot{K}$	ign.
50·04	8·95	0·24	9·59	0·20	11·48	18·02	0·81	0·08	0·59=100

The soda is attributed to feldspar which was detected in the mineral with a lens.

7. *Feldspar of the Diorite of Pont Jean.*—The hornblende is associated with a greenish feldspathic paste containing striated crystalline tables of a triclinic feldspar, which sometimes have a radiated arrangement. B.B. more fusible than the hornblende, as

usual with the feldspar of diorites; attacked by sulphuric acid. Composition :—

$\ddot{S}i$	$\ddot{A}l$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$	$\dot{N}a$	$\dot{K}$	ign.
53·05	28·66	0·90	*trace*	6·37	1·51	4·12	2·80	2·40=99·81

It is a variety of labradorite. Delesse concludes that the radiated structure is found more especially in feldspars containing the smaller proportions of silica.

8. *Aphanite of Saint-Bresson* (*Haute-Saône.*)—The color is deep green, verging towards grayish black. It is very tough and compact. It fuses easily in a glass furnace and affords an obsidian about as hard as that of feldspar. G.=2·968. Composition :—

$\ddot{S}i$	$\ddot{A}l, \dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$ (diff.)	$\dot{N}a$	$\dot{K}$	ign.
46·83	30·33	*trace*	9·55	6·86	3·57	0·87	1·99=100

The small proportion of silica is worthy of note. The main ingredient is a feldspathic paste, which it is difficult to assign to any species.

9. *Andesite of the Diorite of Faymont.*—Lustre a little greasy and with the other characters of andesite. Composition :—

$\ddot{S}i$	$\ddot{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{N}a, \dot{K}$, (diff.)	ign.
59·38	25·57	*trace*	6·50	7·30	1·25=100

The crystals are often penetrated or enclosed by quartz, showing that they were formed amid an excess of silica.

10. *Hornblende of the Diorite of Faymont.*—Occurs in black lustrous laminæ and in crystals. Composition :—

$\ddot{S}i$	$\ddot{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$ (diff.)	Alkalies	ign.
41·99	11·86	22·22	9·55	12·59	1·32	0·47=100

Associated with the hornblende, there is sometimes black mica, pyrites, a little magnetic iron, and sphene.

11. *Feldspar of the porphyry of Schirmeck.*—This feldspar is in tables, oblong and striated, and pertains to the triclinic system. It is slightly greenish and a little pearly in lustre. G.=2·686. Composition :—

$\ddot{S}i$	$\ddot{A}l, \dot{F}e$	$\dot{C}a$	$\dot{N}a, \dot{K}, \dot{M}g$ (diff.)	ign.
65·74	18·49	4·17	10·60	1·00=100

Delesse considers it an oligoclase, judging from the proportion of silica and amount of lime.*

Wolfram.—Analyses by Robert Schneider of Halle, (J. f. pr. Chem., xlix, 322.)

	$\ddot{\ddot{W}}$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$	
1. Zinnwald,	76·01	9·81	13·90	1·19	——	$=100·91=2\dot{F}e\ddot{\ddot{W}}+3\dot{M}n\ddot{\ddot{W}}$.
2. Hartz, Mine Glasebach,	76·04	19·61	4·98	0·28	*trace*	$=100·92=4\dot{F}e\ddot{\ddot{W}}+\dot{M}n\ddot{\ddot{W}}$.
3. Hartz, Mine Pfaffenberg,	76·21	18·54	5·23	0·40	0·36	$=100·74=4\dot{F}e\ddot{\ddot{W}}+\dot{M}n\ddot{\ddot{W}}$.
4. Hartz, Mine Meiseberg,	76·25	20·27	3·96	0·28	0·15	$=100·91=5\dot{F}e\ddot{\ddot{W}}+\dot{M}n\ddot{\ddot{W}}$.

* M. Delesse states in a note that geologists wishing collections of the rocks of the Vosges described in his memoirs, can obtain them by addressing M. Mareine, conducteur des ponts-et-chaussées, à Remiremont (Vosges.) He will give full labels with the specimens, and charges the moderate sum of 30 francs for 100 specimens.

This last result is the mean of three analyses; the per-centage relation for the formula is, $\dot{W}$ 76·36, $\dot{Fe}$ 19·74, $\dot{Mn}$ 3·90 = 100.

Schneider concludes from his investigations that the true view of the composition of Wolfram is expressed by the genera formula $\dot{R}\,\ddot{W}$, making wolframic or tungstic acid to contain three atoms of oxygen.

Native Copper containing Silver from Chili, (M. F. Field, Quart. J. Chem. Soc., No. ix, iii, 29.)—A native copper from a mine about twenty leagues east of Coquimbo and six from the Cordillera of the Andes, afforded Mr. Field for one specimen, Copper 98·91, silver 1·09 = 100; for a second, of a whitish color, Copper 92·4, silver 7·6 = 100.

Native Gold.—Analyses by A. Levol, (Ann. Ch. Phys., [3] xxvii, 310.)

	Gold.	Silver.	Copper.	Ratio of Au to Ag.	
1. Senegal, grains,	84·50	15·30	0·20	6 : 1 =	Au 84·6
2. " large scales,	86·80	11·30	0·90	8 : 1 =	88·0
3. N. America, grains,	91·00	8·70	0·30	12 : 1 =	91·6
4. California, a piece,	92·70	6·90	0·40	14 : 1 =	92·7
5. Senegal, irregular grains,	94·00	5·85	Plat. 0·15	18 : 1 =	94·2
6. A piece, loc. not given.	98·30	1·70		58 : 1 =	98·1

On the Meteoric Iron of Zacatecas; by Dr. C. Bergemann of Bonn., (Pogg. Ann., lxxviii, 406.)—The Zacatecas meteorite, which has been described by Sonneschmidt, Humboldt, and others, has been recently analyzed by Dr. Bergemann. The mass weighs over 20 cwt. It has a light steel gray color within, a hackley fracture, and the crystalline figures are small and irregular. Specific gravity according to Bergemann 7·4891, at 9° C., which agrees with the determinations by Burkart and Rumler. Analysis gave for its composition:

Fe	Ni	Co	Cu	Mg	Mn	C	S	Ca	a little	Fe	Fe, Ni, P	$\dot{Fe}\ddot{C}r$
85·094	9·895	0·668	0·630	0·187	*trace*	0·164	0·845		0·334		1·649	1·482

Dr. Bergemann thence deduces for its actual constitution—

Nickeliferous iron, ...	93·77
Magnetic pyrites, ...	2·27
Chromic iron, ...	1·48
Phosphuret of nickel and iron, . .	1·65
Carbon, ...	0·49
	99·66

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the Preparation of Metacetonic Acid;* by Dr. F. Keller, (Chem. Gazette, May 1st, from Liebig's Annalen, Feb., 1850.)—A quantity of wheat paste is mixed with ten parts of water at 122°–140° F.; one fourth its weight of scraps of leather is then added with a quantity of chalk and the whole left in a warm place to ferment. At the end of a few days in summer, the process is complete and a light spongy mass subsides. The lime salt is converted into a soda salt, and the acid separated by sulphuric acid, is found to be a mixture of metacetonic with acetic acid. These are separated by saturating a portion with carbonate of soda, adding the remainder and distilling off the metacetonic acid, which by this process is readily obtained in large quantities. T. S. Hunt.

2. *On the Amid Compounds of Tungsten;* by Prof. Wöhler, (Chem. Gazette, May 1st, from Göttingen Nachrichten, 1850.)—When dry ammonia is passed over protochlorid of tungsten, a reaction takes place at first spontaneous which is completed by the aid of a gentle heat, sal-ammoniac and hydrogen gas being evolved. The product is a black partially fused mass, which evolves ammonia when heated in the open air and finally burns, yielding yellow tungstic acid. Heated to whiteness in a charcoal lined crucible, it leaves metallic tungsten, and a similar result is obtained in a current of hydrogen gas at a low red heat, ammonia being disengaged. Fused with hydriodate of potash, a tungstate is formed with the evolution of hydrogen and ammonia. From the results of analysis, M. Wöhler concludes, that there are two very similar compounds, a nitruret and amidid of tungsten, the second being a product of the decomposition of the first by the action of hydrogen, and that the two are generally obtained in a state of admixture. He represents the one as $2W\,N+WNH_2$ and the other as W_2N+WNH_2.

The action of ammonia upon tungstic acid at a low red heat yields a substance resembling the latter in its properties, of which the composition is represented by $3WN+W_2NH_2+2WO_2$. Identical with or very similar to this is the product obtained by igniting out of contact of air a mixture of tungstate of potash with chlorid of ammonium, which was a long time since described by the author as the black oxyd of tungsten. It however evolves hydrogen and ammonia by the action of hydrate of potash, and even when heated alone. When heated to whiteness in a close vessel, it leaves metallic tungsten.

Wöhler finds, that contrary to the statement of Berzelius, tungstic acid is not reduced to the metallic state by the action of hydrogen; at a temperature above the melting point of silver an oxyd is obtained which is not farther changed. It is of a violet brown color, and under a magnifier appears crystalline with a metallic lustre.

[These different combinations of tungsten, nitrogen and hydrogen, with the addition in some cases of oxygen, will probably be found to correspond to different ammoniacal salts of the polymeric forms

of tungstic acid as yet imperfectly known. The different amids of phosphoric acid already described by M. Gerhardt are analogous compounds.] T. S. H.

3. *On the Decomposition of Iodid of Potassium;* by Prof. SCHÖNBEIN, (Chem. Gazette, May 1st, 1850, from Pogg. Annal., lxxviii, p. 513.)—The anhydrous metallic acids, arsenic, molybdic, tungstic, antimonic and chromic, when triturated with iodid of potassium, separate iodine even in the cold, and abundantly by the aid of heat; artificial stannic acid as well as the native tin-stone effect a similar decomposition by heat. With bichromate of potash the whole of the iodine may be expelled, while neutral chromate of potash and oxyd of chromium remain behind; three parts of the bichromate suffice to decompose two of the iodid, the reaction being

$$5(KO,2Cr\,O_3)+3KI=8(KO\,Cr\,O_3)+Cr_2\,O_3+3I.$$

Anhydrous perchlorid of iron liberates iodine from the iodid of potassium at the ordinary temperature, and a highly concentrated solution of the perchlorid of iron, mixed with an equally concentrated solution of the iodid, precipitates a large portion of the iodine in a crystalline form; $Fe_2\,Cl_3+KI=2Fe\,Cl+K\,Cl+I$.

The persulphate and all the persalts of iron act in a similar manner, so that the peroxyd of iron may be used instead of the peroxyd of manganese to separate iodine from alkaline iodids.

The dry persalts of copper, even the carbonate, liberate iodine from the iodid on the application of heat.

The bromid of potassium in the dry way is affected by most of these reagents, but with less ease than the iodid. Bichromate of potash and persalts of iron are most efficient; the latter may also be employed in the moist way to obtain bromine by distillation.

The chlorids of K and Na are not decomposed by any of the above agents, even at a strong heat; but a partial decomposition is effected especially with bichromate of potash and the chlorids of Ba, Sn, Ca and Mg, attended with the evolution of chlorine and the formation of neutral chromates and oxyd of chromium. T. S. H.

4. *On Furfurol;* by A. CAHOURS, (Ann. de Chim. et de Phys., xxvi, 277).—The author has reëxamined this substance which he prepared by the action of sulphuric acid upon bran as recommended by Dr. Fownes;* by employing a little less sulphuric acid he obtained a much larger portion of the oil, 100 parts of bran yielding 2·75 parts of furfurol. The distillation of bran with water alone, does not yield any, nor can it be obtained from lignine, starch or gluten, even by the aid of sulphuric acid.

The analyses of M. Cahours confirm the exactness of the composition given by Fownes to furfurol. The specific gravity of its vapor is 3·342–3·346, corresponding for two volumes to the formula $C_5\,H_4\,O_2$, the equivalent which had already been adopted by Laurent and Gerhardt.

Chlorine and bromine give with furfurol only resinoid products; nitric acid, whether concentrated or diluted, acts energetically upon it, and

* This Journal, new series, vol. ii, p. 407.

gives as the final product oxalic acid. M. Cahours has also confirmed the results of Fownes as to furfuramid and furfurine. The action of sulphuretted hydrogen upon an alcoholic solution of furfuramid or of hydrosulphuret of ammonia on furfurol produces a sulphuretted compound *thiofurfurol*, $C_5H_4(OS)$. Seleniuretted hydrogen gives an analogous compound. By dry distillation thiofurfurol is transformed into a substance crystallizing in colorless needles, very soluble in alcohol and slightly soluble in boiling water. It contains $C_9H_8O_2$ and is formed from two equivalents of furfurol; $2C_5H_4(OS)=C_9H_8O_2+CS_2$.

T. S. H.

5. *On the action of Chlorine upon Lactic Acid;* by G. STAEDELER, (Ann. der Chem. und Pharm., lxix, 333.)—The author has recognized the production of *aldehyde* and *chloral* by the distillation of lactic acid with a mixture of sea-salt, peroxyd of manganese, and sulphuric acid. When the quantity of chlorine is small the aldehyde predominates. T. S. H.

6. *Preparation of Oxychlorid of Carbon;* by A. W. HOFMANN, (Ann. der Chem. und Pharm., lxx, 129.)—A convenient and rapid mode of preparing this compound of oxyd of carbon and chlorine is to pass a stream of carbonic oxyd gas through perchlorid of antimony in ebullition; the salt is reduced to a protochlorid. This reaction may serve to detect oxyd of carbon in a gaseous mixture, for the odor of the oxychlorid is very characteristic. T. S. H.

7. *On the Preparation of pure oxyd of Cobalt;* by P. LOUYET, (Comptes Rendes des Trav. de Chim., Oct., 1849.)—The ordinary process for purifying oxyd of cobalt from the oxyds of nickel and iron with which it is almost always associated, is that of M. Liebig, which consists in converting them into sulphates and exposing the dried salts to a red heat. By this means the sulphates of iron and nickel are decomposed with the escape of their acid, while the sulphate of cobalt is unchanged. The author has however found that when mixed with a large amount of sulphate of cobalt, a portion of the iron salt escapes decomposition even after a long continued red heat. He recommends for the purification of the product thus obtained the following process.

The calcined sulphate is dissolved in water, and a portion of gelatinous hydrated oxyd of cobalt is added, or what is the same thing, a quantity of carbonate of soda sufficient to precipitate in the form of carbonate a portion of the cobalt. The mixture is digested for some time at a boiling heat, until the violet color of the oxyd of cobalt is replaced by the dirty yellow of oxyd of iron, from the decomposition of the iron salt by the cobaltic oxyd. If the cobalt precipitate be slightly in excess, the salt of cobalt remaining in solution contains not the slightest trace of iron; the nickel of the impure oxyd is entirely removed by the previous process of calcination. T. S. H.

8. *On the action of heat upon the Caprylate of Lime;* by G. GUCKELBERGER, (Ann. der Chem. und Pharm., lxix, 201.)—The dry distillation of this salt mixed with an excess of hydrate of lime yields an oily matter which after a little time becomes solid, and is purified by crystallizing in boiling alcohol. It is *caprylone*, an acetonid like that afforded by the lime salts of the homologous acids, and forms a

white crystalline mass resembling china wax. It is lighter than water, in which it is insoluble, tasteless and nearly inodorous; it fuses at 40° C., and boils at 178° C., distilling without alteration. Analysis gives for its formula $C_{15}H_{30}O$, and its formation is by the polymorphosis of two equivalents of caprylate; $2C_8H_{15}BaO_2 - CO_3Ba_2 = C_{15}H_{30}O$.

It is not affected by potash, nor by nitric acid in the cold; by heat the action of the latter is violent, yielding a yellow compound which forms detonating salts and is evidently a nitrized acid. T. S. H.

9. *On the determination of Nitrogen;* by NOELLNER, (Ann. der Chem. und Pharm., lxvi, 314.)—In the determination of nitrogen by igniting the substance with soda-lime after the process of Will and Varrentrapp, the author proposes to pass the ammoniacal vapors through a solution of tartaric acid in absolute alcohol. The bitartrate of ammonia which is thus formed is complely insoluble, and is deposited in a crystalline form. T. S. H.

10. *Examination of Castoreum;* by F. WOEHLER, (Ann. der Chem. und Pharm., lxvii, 360.)—The author had already suggested the existence of *phenol* in this substance, and has been able to verify it by distilling the castoreum with water, when a small portion of an oily liquid having all the reactions of phenol was obtained. The residue of this distillation yielded crystals of *benzoic acid* and *salicine*, and the mother liquid from the crystals of the benzoic acid gave with ferric salts the reactions of *salicylic acid*. T. S. H.

11. *On the Composition and Metamorphoses of Conine;* by J. BLYTH, (Compt. Rend. des Trav. de Chem., Oct., 1849, from Ann. der Chem. und Pharm., lxx, 73.)—The recent analytical results of this chemist do not accord with those already obtained by M. Ortigosa. The difficulty of obtaining the alkaloid in a pure state is such that it is not easy to deduce a reliable formula except from the analyses of its saline combinations. From a careful comparison of the results, M. Gerhardt is led to retain the formula already adopted by him in his Précis (vol. ii, p. 66), $C_8H_{15}N$, or in the ordinary notation, $C_{16}H_{15}N$; that of Mr. Blyth is $C_{17}H_{17}N$, and that of Ortigosa $C_{16}H_{16}N$, neither of which gives a number of equivalents of nitrogen and hydrogen divisible by 4. The results obtained by M. Ortigosa approach very closely to those calculated from M. Gerhardt's formula.

According to Mr. Blyth, the boiling point of conine is 168°–171° C.; but it is altered by heat so that the temperature rises during the distillation. Its density is ·878. It is volatile at ordinary temperatures, giving off a pungent odor which affects the eyes and produces white fumes with nitric, hydrochloric and acetic acids. In a dry state it does not affect test papers, but on the addition of a drop of water its reaction is strongly alkaline. Conine readily coagulates albumen, and precipitates the salts of Cu, Pb, Zn, Mn, Al and Fe, it precipitates also nitrate of silver but an excess of conine dissolves the precipitate; it dissolves the chlorid of silver as readily as ammonia. Most of the salts of conine are decomposed by evaporation, leaving gummy residues; many of these are crystallizable as the hydrochlorate, but very deliquescent.

Conine is a very alterable substance and resinifies by the action of the air; the ordinary product of its oxydation is *butyric acid*, which is obtained from it in various ways,—by boiling a solution of the chloro-

platinate, by acting upon it with an excess of bromine and evaporating in the product *in vacuo*, by chromic and nitric acids, etc. According to M. Gerhardt the reaction will be as follows $C_8H_{15}N+2H_2O+O_2=2C_4H_8O_2+NH_3$.

Mr. Blyth supposes a simultaneous formation of carbonic acid which his formula demands. T. S. H.

12. *On the Composition and Metamorphoses of Piperine;* by TH. WERTHEIM, (Comptes Rend. des Trav. de Chim., Oct., 1849, from Annal. der Chem. und Pharm., lxx, 58.)—The *chloro-platinate of piperine* is obtained by mixing concentrated alcoholic solutions of piperine and bichlorid of platinum, and having added an excess of concentrated hydrochloric acid, abandoning the mixture to spontaneous evaporation. It is obtained in very large fine crystals of an orange red color, which are very little soluble in water, but are apparently decomposed by a large portion, and are to be washed with strong alcohol. The composition of this salt deduced by the author from his analyses is $(C_{70}H_{37}N_2O_{10}, ClH, PtCl_2)$, and he concludes that crystallized piperine contains 2 eq of Aq, and is $C_{70}H_{37}N_2O_{10}+2HO$.

When piperine is mixed with three or four parts of soda-lime and exposed to a temperature of 150°–160° C., there passes over a large amount of a colorless oily alkaloid, without a trace of ammonia, which is found to be identical with the *picoline* of Mr. Anderson. The residue is brown and contains a yellowish azotized resin having acid properties. If the mixture of piperine and soda-lime is heated to 200° C., ammonia is disengaged with the picoline, and the residue contains an uncrystallizable acid which is not nitrogenous.

The formula above proposed does not correspond with the law of divisibility, and M. Gerhardt proposes in its place the following formula deduced from the analyses of M. Laurent and his own, and closely according with the results obtained for the chloro-platinate by the author. $C_{35}H_{36}N_2O_5+Aq$, or in the German notation, $C_{70}H_{36}N_2O_{10}+2HO$.

He remarks that the decomposition evolving picoline and ammonia, shows piperine to be a diamid, analogous to the *carbanilamid* of M. Chancel,* in which the two equivalents of alkaloid will be represented by picoline and ammonia coupled with a non-azotized (bibasic) acid; the azotized acid resinous body described, will be the monobasic amid-acid of the former. These two acid bodies have been analyzed by M. Wertheim, but not being crystallizable we have not yet data for determining satisfactorily their composition. T. S. H.

13. *On a New Gunpowder;* by M. AUGENDRE, (Comptes Rendus, in Chemical Gaz., May, 1850.)—The proportions giving least residue with maximum effect are—

Powdered crystallized yellow prussiate of potash, . .	1 pt.
" white sugar, ...	1 "
" chlorate of potash, ...	2 "

The ingredients separately powdered are carefully mixed, small quan-

* This Journal, March, 1850, p. 275.

tities may be rubbed together in a mortar; for large quantities 2 or 3 per cent. of water must be added and the mixture made in a bronze mortar with a wooden pestle, and it may then be granulated and dried.

This compound differs from ordinary gunpowder in being explosive even in the form of fine powder, no granulation is therefore needed. Other advantages claimed for it are its easy formation, the ingredients previously powdered may be mixed only when wanted—the want of action of air on the separate materials, while charcoal for gunpowder is injured by exposure; and lastly, the greater force.

On the other hand are its erosive effect on iron barrels, for which bronze must be substituted, and its dangerous inflammability.

[This compound having already obtained a newspaper notoriety has probably been very generally tried. The cost of materials and the difficulty of keeping it will be a bar to very extensive use. In our own trials, it was found to become somewhat moist, and the original pulverization was found difficult in the case of the sugar and prussiate of potash.

It is dangerous to introduce gunpowder, charcoal or sulphur; the smallest quantity caused, in the hands of the discoverer, a tremendous explosion.] G. C. SCHAEFFER.

14. *Purification and properties of Chloroform;* by Prof. WM. GREGORY, M.D., (Med. Jour. Sciences, in Chem. Gaz., May, 1850.)—Prof. G. in general confirms the results of Soubeiran and Mialhé.* Still even from the hands of the best manufacturers, chloroform has until recently been found contaminated by chlorinated oils mentioned in our former notice. Prof. G. considers the disagreeable effects of chloroform as entirely due to these oils. It is therefore a matter of some consequence to have delicate tests for the purity of this important substance.

Pure and colorless sulphuric acid of 1·84 at least, on agitation is colored yellow or brown, as the oil is more or less impure. Perfectly pure chloroform does not color the acid.

Pure chloroform when poured upon the hand or a handkerchief, rapidly evaporates, while the less volatile oils remain and are recognized by their color, which is quite persistent. Dr. Simpson mentioned to the author that while using a chloroform, which had so constantly produced unpleasant effects that he threw it away, the handkerchiefs became quite offensive from the smell left upon them which remained after washing. Another test is the specific gravity which for the perfectly pure article is 1·500.

Mr. Kemp, the author's assistant, also noticed another remarkable test of purity. As soon as the acid was no longer colored by the chloroform, the latter exhibits a strong convexity downwards toward the acid.

The process for purification proposed by Mr. Kemp is to agitate with strong pure sulphuric acid, allowing the liquid to remain in contact, with occasional agitation. Half its volume of acid will be enough, and if but little color is given, a second use of the acid is not needed, but

* This Journal, Jan., 1850, p. 115.

this should be tried on a small portion in a test tube for greater certainty—the purification is finished with peroxyd of manganese, with which it is to be agitated and left in contact until the odor of sulphurous acid is removed.

Redistillation is not required, in fact, is not necessary to the manufacturer, who has only to wash well the first product with water and purify as above.

As an instance of what the author considers the gross ignorance of persons pretending to manufacture such articles, he refers to a sample examined by him of sp. gr. about 1·000, and which seemed to have the following origin. The maker obtained two fluids from distillation, not knowing that the heavy one was chloroform he threw it away and put up the lighter, a mixture of pyroxylic spirit, its original impurities, the chlorinated oils and a mere trace of chloroform, and labelled it *pure chloroform.* Almost pure *from* chloroform, Dr. G. well says.

It is useless to call such conduct the result of gross ignorance, for in such cases a gross ignorance is gross rascality. G. C. S.

15. *On the preparation of Chlorate of Potash.*—Prof. F. C. Calvert, in a paper read before the Chemical Society of London, describes the following process as producing a maximum quantity of chlorate. The current of chlorine is passed into a solution of 100 fl. grs. containing 102·33 grs. anhydrous potash—its density 1·1. ·358 grs. quick-lime are to be added and the whole slightly heated. The result was 220 grs. of the chlorate beside about 20 grs. left in the mother water. The precise density of the liquid is important. G. C. S.

16. *Aspartic Acid formed from Bimalate of Ammonia;* by M. Dessaignes, (Comptes Rendus, March, 1850.)—Piria has proved that asparagine and aspartic acid are the amids of malic, as oxamid and oxamic acid are the amids of oxalic acid.* Succinic acid produced in the fermentation of asparagine has also been obtained from the fermentation of the malates in such quantities as to render the malates the best source of this hitherto rare acid.† Still all attempts at forming asparagine or aspartic acid from malic acid have failed, as chemists have not as yet succeeded in forming malic ether.

The author has however reached the desired end by the dry distillation of bimalate of ammonia. The residue with a heat of about 370° is a sparingly soluble amorphous reddish mass. Well washed with hot water this mass is changed into a very stable acid which however is not the aspartic. Heated for some time with hydrochloric acid this substance is no longer precipitated by water and yields on evaporation crystals containing hydrochloric acid which are easily purified. It is only necessary to dissolve these in boiling water, divide the solution, neutralize one-half in the ammonia and add the other half, to obtain on cooling a quantity of prismatic crystals of aspartic acid.

The form of aspartic acid thus obtained is not identical with that of the same acid from asparagine, but the salts are identical in form with the aspartates hitherto known. Analysis renders it certain that this is in reality aspartic acid.

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* This Journal, Nov., 1848, p. 420. † Ibid, Jan., 1850, p. 117.

[Possibly the intermediate compounds above described may be an amid of one of the acids into which the malic is so readily transformed by heat—but as the anhydrid of malic acid is known, this acid would be the anhydrid of aspartic acid.] G. C. S.

17. *Stibethyle;* by C. Löwig and E. Schweitzer.—The authors decomposed "iodid of ethyl" by the alloy of antimony and potassium, formed according to Serullas' process by igniting antimony and cream of tartar. The decomposition is violent, and the product, *stibethyle*, is spontaneously inflammable—hence numerous precautions are required in manipulation. The formula given is $C_{12} H_{15} Sb$, which the authors regard "equivalent with antimoniuretted hydrogen in which three atoms of hydrogen are replaced by three atoms of ethyle," and hence conclude, that "*its composition presents nothing remarkable.*" They also regard it as a "radical" analogous to kakodyle.

Kakodyle has not held its ground as a radical, and the new substance must soon lose all claim to that title.

Stibethyle seems to form a fine crystalline salt with nitric acid, but the property of forming a salt with an acid has never been claimed as belonging to radicals, but to their oxyds.

The following view of the composition of this substance seems to be probable, and with due respect to its able and distinguished discoverers, we consider it as highly remarkable.

Antimony like phosphorus belongs to the nitrogen class and forms corresponding compounds. Antimoniuretted hydrogen is hence a sort of ammonia, we can hardly say ammonia with its nitrogen replaced by antimony, although this expression is used. $Sb H_3$, or stib-ammonia, can take the place of $N H_3$. In the compound ammonias of Wurtz, that of the caproic series would be $C_{12} H_{15} N$. Stibethyle is then caproamine, in which antimony takes the place of nitrogen. The spontaneous inflammability of the new substance is owing to the presence of antimony, which in its relations to oxygen differs from nitrogen.

Wertheim has shown that by the action of hydrate of potash, narcotine yields $C_6 H_9 N$, or the compound ammonia of the metacetic series. We add a tabular view of the known compound ammonias, named according to the series to which they belong.

		Discovered by
Hydric, . .	$H_3 N$	———
Formic, . .	$C_2 H_5 N$	Wurtz.
Acetic, . .	$C_4 H_7 N$	"
Metacetic, . .	$C_6 H_9 N$	Wertheim.
Butyric, . .	$C_8 H_{11} N$	Anderson.
Valeric, . .	$C_{10} H_{13} N$	Wurtz.
Caproic, . .	$C_{12} H_{15} Sb$	Löwig and Schweitzer.

G. C. S.

18. *Action of Nitric Acid on Rhubarb.*—M. Garot (Journ. de Pharm. et de Chem., Jan., 1850) describes the result of the action under the name of *erythrosin.* From 10 to 20 per cent. may be obtained from the rhubarb. No analysis has been made—but there seems to be a mixture of rhubarbine of former authors and a nitric compound,

probably similar to acids derived from aloes by the action of nitric acid. Like these acids, erythrosin possesses high tinctorial power, and is recommended for its properties as a suitable dyeing material.

G. C. S.

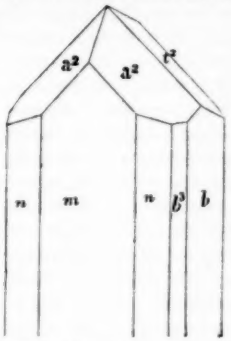
19. *On the Atomic Weight of Molybdenum;* by N. J. Berlin, (J. f. pr. Chem., xlix, 444, 1850.)—From the analyses of three molybdates of ammonia, Berlin deduces for the atomic number of molybdic acid, (Mo) as follows, 875·75, 876·57, 873·42, 873·25, affording the mean 874·75. He hence concludes that the number obtained for molybdenum by Svanberg and Struve, 575·83, based on 200 as the value of sulphur, must be right or very near the true one; and not 588·966, based on 200·75 as the value of sulphur. Hence also 200 is the true atomic number for sulphur.

II. Mineralogy and Geology.

1. *On a new Spodumene Locality at Norwich, Mass.;* by C. Hartwell, Member of the Theological Institute of East Windsor, Ct., and E. Hitchcock, Jr., of Amherst, Mass.—This locality, in the north part of Norwich, was discovered by Mr. Eben Weeks of that place, and opened by the writers. The spodumene occurs in large veins of quartz, surrounded and partly intermingled with albite and feldspar, running north and south through a hill of mica slate. It has been seen for the most part in one large vein, which appears at the surface only in two places, about thirty rods apart. Associated with the spodumene, are crystals of staurotide of a new form, mica, imperfect specimens of beryl, and enormous black and blue tourmalines not perfect in figure. One vein, mostly albite, exhibits the spodumene in a decomposed state nearly as soft as gypsum. The spodumene is doubtless abundant, though a large quantity is not attainable without great expense. Crystals have been obtained with the breadth ranging from one-half inch to four inches, and some much larger are visible in the rock. It is usually massive in the albite, extended into the quartz in crystals, terminated at one end, and sometimes more than a foot in length. The longest individual that has been obtained measures eleven and a half inches. Much of the mineral has a beautiful pinkish hue. The crystals are usually opaque, but some are nearly translucent in parts. Good specimens are acquired with difficulty. One reason lies in the perfection of the cleavages, especially that parallel with the orthodiagonal, which renders them easily broken. Another lies in the nature of the gangue, as the quantity is full of rifts, rendering blasting difficult, and allowing access to the mineral for the weather, which has given it all a rusty appearance. The crystals can be cleaned by acid with no injury except perhaps a little damage to the lustre. The forms of the terminations are various. The crystal having the greatest number of planes, has been described in Dana's System of Mineralogy, 3d ed., p. 693, and now belongs to Prof. B. Silliman, Jr. Other crystals are similar in general form, but with a less number of planes. One of the specimens has only P wanting, and o', o'' are well developed. In others the plane a, o' and o'' are absent as well as P, as in the following figure; but the plane a is usually present.

The angles obtained with the common goniometer are as follows:—

m (back plane) : t^2	$=102°\ 30'$–$106°$
n : t^2	$=134°$
b : t^2	$=138°\ 20'$
a : t^2	$=148°$
t^2 : t^2 (over the summit)	$=80°\ 30'$
m : a^2	$=116°$
b : a^2	$=134°$
n : a^2	$=144°$
b^3 : a^2	$=142°$
b : a^2	$=135°$



The angle m : t^2 is generally about $102°\ 30'$, although one crystal gave us $106°$. *

The surface m in all the specimens, is finely covered with lines, as mentioned by Dana.

The new form of the staurotide occurring at the same locality,† gave us the following angles. (See figure, p. 121.)

P : t $=131°$

b^2 : b^2 (over b)$=86°$

This form is not usually found entire, but a few specimens have been obtained with only a slight imperfection. The plane P is frequently inclined from the true position, and often but one is found. In some individuals the plane b is nearly or quite obliterated by the planes N, in others it deeply truncates the crystal. Many of the crystals appear joined to the spodumene, in connection with which it usually occurs. The mineral is very brittle, and hence arises the difficulty of obtaining good forms.

2. *Age of the Nummulitic formation of the Alps;* (from the Address of Sir C. Lyell before the Geol. Soc., Quart. Jour. Geol. Soc., No. 22, 1850.)—In the chronological classification of the materials composing the crust of the earth, it has been often asked, whether we ought to ascribe to the older tertiary epoch, or to the cretaceous system, the great nummulitic formation of the Alps, and other parts of Europe. This much-controverted question,—one, as I shall presently point out, of the highest theoretical interest, in reference to the hypothesis of the unabated intensity of the existing agents of change,—was declared by M. Boué, some years ago, to be the great problem of the day, and Sir R. Murchison has therefore devoted to its consideration a large portion of his memoir. M. Boué indeed announced in 1847 his own conviction that the nummulitic rocks belonged to the eocene or lower tertiary period, and remarked, in a paper read to the French Geological So-

* New measurements of several crystals recently received confirm this result. In one crystal, 109° were obtained; but in those of the best planes, using a cleavage surface for *m*, the angle obtained was 103°.— J. D. D.

† See last number of this Journal, p. 121.

ciety in that year, how much delight Alexander Brongniart would have experienced, had he lived to see one of his boldest and most startling generalizations thus crowned with success.* Al. Brongniart had in fact declared many years before, that the shells of the summit of the Diablerets, one of the loftiest of the Swiss Alps, which rises more than 10,000 feet above the sea, were referable to species characteristic of the eocene strata of the neighborhood of Paris. He only felt considerable hesitation, he said, in assigning to them so modern a date, because the overlying limestones were so compact and homogeneous as to agree in lithological character with much older secondary rocks.

Several of the most animated discussions which have taken place in this room since 1825, have turned, as you will recollect, on this subject, especially when the fossil shells brought by Mr. Pratt from Biaritz in the Pyrenees were laid upon our table. A decided opinion was then expressed by many of us that the nummulitic series of that southern chain must be referred to the lower part of the eocene group, as it was made clear that the proportion of fossil species common to the Biaritz beds and the chalk was extremely small—much too small to imply a cretaceous age for the strata in question, or even a zoological passage from the cretaceous to the tertiary formations. They who have read with care the successive numbers of the 'Bulletin' of the Geological Society of France, are aware how much that body has been occupied with the same problem, and how steadily the evidence in favor of the same important conclusion has been gaining strength. M. d'Archiac, writing in 1847 on the fine collection of Biaritz shells submitted to his inspection by Mr. Pratt, observed that forty-eight, or one-fourth of the whole series, were identical with fossils of the lower eocene of the Paris basin, while the rest were all tertiary forms except four, which belonged to species of the chalk.† In a paper by M. Deshayes, read to the Geological Society of France in June, 1844,‡ that able conchologist declared, after examining the Biaritz fossils, "that the whole of the nummulitic system must be classed as tertiary; an opinion confirmatory," he said, "of the results previously arrived at by M. Leymerie in the Corbières, and of M. Bertrand Geslin in the Alps." Lastly, I may observe, that you will find similar opinions recorded in the 'Bulletin,' either in the memoirs or verbal comments of MM. Deshayes, Charles Desmoulins, Raulin, Leymerie, Tallavigne, Delbos, Desor, Boué, Archiac, and Alcide D'Orbigny, all published in the course of the last six years. Whether a real transition from the cretaceous to the tertiary strata can be made out, is a point which has also been fully discussed, and how far the Maestricht beds are represented in the Pyrenees. It appears from the researches of MM. Desmoulins and Raulin, that some few of the characteristic fossils of Maestricht have really been found in that chain; but you will, I think, agree with M. Deshayes, that they are not enough to establish the existence of any true equivalent of the Maestricht group—that distinct and uppermost division of the chalk to which the Faxoe coralline limestone in Seeland, as well as the pisolitic strata of Sezanne near Paris, are referable.

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* Bulletin, vol. v, 2nd series, pp. 69, 71.
† Bulletin, vol. iv, 2nd Series, p. 1006.
‡ Translated in Quart. Journ. Geol. Soc., 1845, p. 111.

When we consider that the age of the nummulitic formation of the Pyrenees, however clearly it may now be determined to be tertiary, has been regarded by so many able authorities as a subject of perplexity and debate up to so late a period, we cannot feel surprised that MM. De Beaumont and Dufrénoy, in constructing their geological map of France many years before, should have referred these strata in the Alps, and in the regions bordering the Mediterranean, to an age anterior to the calcaire grossier of Paris, especially when we learn that even now M. Agassiz affirms, that out of 139 species of echinoderms described by him from the nummulitic beds of the Mediterranean, one species only is common to them and the calcaire grossier. The same geologist maintains that all the fish of Glarus and Monte Bolca, which according to the latest opinions must be classed as eocene, differ entirely from those of Sheppy.* Yet I am by no means disposed to question, on the ground of this want of agreement in the ichthyolites, that the Glarus slates are in truth tertiary, still less to doubt that the limestone of Monte Bolca belongs to the same period: I have always regarded the latter as eocene from the time when I visited that locality in company with Sir Roderick Murchison in 1828. You have seen also, in the classification of the three successive eocene formations established by Mr. Prestwich for the older tertiary deposits of Great Britain, that while each division is characterized by its peculiar assemblage of shells, a part only of the species pass from one division to another, and that the specific difference of the mammalia belonging to each division, and still more of the first, as determined by Agassiz, is extremely marked.

The researches, above alluded to, of Sir Roderick Murchison in the Alps in 1847, and the palæontological evidence of various eminent writers brought together by him in illustration of his views, have, I think, shown unequivocally, that, together with the nummulitic limestone, an enormous thickness of overlying strata of dark-colored slates, marls, and fucoidal sandstones, provincially called Flysch, are separable from the cretaceous system of Northern Europe, and must also be regarded as lower eocene. His attempt however to make out a passage from the tertiary to the secondary series by means of an intervening group of marls, green sandstone and impure limestone, appears to me to be far less successful, since a true representative of the Maestricht beds is wanting in the Alps, or is very ill-defined, and no other equivalent assemblage of organic remains is enumerated sufficiently rich in forms, or intermediate in character, to fill up the wide gap between the eocene strata and the chalk.

I have dwelt thus at length on the age of the nummulitic series, because its recognition as a tertiary deposit draws with it consequences of the utmost theoretical importance, and is singularly confirmatory of a remark made by M. Desnoyers many years ago in his address to the French Geological Society, namely, "that the more the Alps are studied the younger they grow." This saying was elicited by the admission by competent observers, that certain schistose rocks of great thickness, containing dark writing slates, originally classed as "transition

* Bulletin, vol. v, pp. 414, 415.

formations" by some of the followers of Werner, and regarded as of palæozoic age, were really secondary. Now we are called upon to go much further; for these same strata belong to the flysch, and therefore constitute what is by no means the base of the eocene system. To the English geologist who is old enough to remember when all the soft clays and loose sands overlying the chalk, some of them containing shells of species identical with those now living, were looked upon as very modern, and as the creations of yesterday, in comparison with the rocks of the higher Alps, it may well appear a startling proposition to learn that the clay of London was in the course of accumulation as marine mud at a time when the ocean still rolled its waves over the space now occupied by some of the loftiest Alpine summits. It will follow, moreover, as a corollary from the same data, as before hinted, that not only the upheaval of the Alps, but all the principal internal movements, dislocations, inversions and contortions of the strata, are subsequent to the origin of the nummulitic deposits, and had not therefore even commenced till great numbers of the eocene vertebrate and invertebrate animals had lived and died in succession.

3. *On the Geographical Limits of the Chalk Formation;* by LEOPOLD VON BUCH, (from the Monatsberichte der Akademie der Wissenchaften zu Berlin, für 1849, p. 117. Compare also, Betrachtungen über die Verbreitung und die Grenzen der Kreide-Bildungen, Bonn, 1849. Aus den Verhand. des naturhist. Ver. der. Pr. Rheinlande; cited from the Quart. J. Geol. Soc., No. 21.)—The small extent towards the poles which the chalk formation attains, compared with the Jurassic strata, and still more with the palæozoic deposits, has been regarded by Dr. Boué, not without some probability, as the most ancient known effect of the influence of climate on the fauna of former worlds. In reality the most northerly point on the whole earth in which chalk has as yet been found is, according to Prof. Forchhammer's determination, in the vicinity of Thistedt in Jutland, not quite in 57 degrees of latitude, or in that of Aberdeen in Scotland, of Calmar, Mitau, Twer and Casan. In the British islands the chalk does not reach so far north; the last appears on the south coast of the island of Rathlin near the Giant's Causeway, in the latitude of Apenrade, of Bornholm and of Tilsit. Flamborough Head in 54° is its last appearance in England. In Russia this limit always sinks deeper towards the south. From Grodno, where the chalk still appears in 54°, it runs, as laid down in Murchison's masterly geological map, through Mohilew and Orel, a degree and a half of latitude south of Moscow, and from Simbirsk downwards along the Wolga, even to the Caucasus. MM. Murchison, Verneuil and Keyserling have very unexpectedly discovered this chalk on the banks of the Ural river, ninety English miles below Orenburg, in 51½°. The Muchodjar mountain determines its limits towards the east. The immense extent of Siberia from the Ural to Ochotzk, and from the Altai to the Icy Sea, has now been so minutely and carefully examined by so many mining engineers, naturalists and gold-seekers, that we may well doubt the occurrence of cretaceous beds in this whole region.

Everywhere along this border, only the upper chalk appears, the strata so peculiarly characterized by *Gryphæa vesicularis*, *Belemnites mucronatus* and *mammillaris*, by *Inoceramus Cuvieri* and *Cripsii*, by

Ostrea Diluvii, *Terebratula carnea* and *semiglobosa*, by *Ananchytes ovata*, *Galerites vulgaris* and *albogalera*, and similar fossils. Older cretaceous strata first appear only in proportion as we descend towards the south, and in the Caucasus, in Daghestan, these older (*neocomien*) beds, according to the excellent observations of Abich, attain a thickness of nearly 5000 feet. It resembles a mighty wave, sweeping far down from the highest summits of the Caucasus and gradually dying away on the margin of the older formations in the plain [on the north].

Beyond the ocean the cretaceous formations terminate in the Atlantic regions of the United States before they have reached the city of New York, so that their limit scarcely touches the 40th degree of latitude, or sixteen degrees lower than in Europe. In Kentucky and Tennessee it remains below 37°. But it is very different far up on the Missouri; this great river flows uninterruptedly from the foot of the Rocky Mountains for 1400 English miles, through strata of chalk, at least as far as the mouth of the Sioux river. This is the result of the accounts and collections of the Prince of Neuwied and of the reports of the celebrated astronomer Nicollet. In these western parts of America therefore, the chalk formation rises to 50° of latitude, or full ten degrees higher than in the eastern portion. Here also it shows a continuous extension greater than that of any other formation known on the surface of the globe. Captain Fremont saw chalk strata, fields covered with *Inoceramus Cripsii*, on the river Platte, Lieutenant Abert on the Arkansas, and as far as Santa Fe in New Mexico, and Dr. Wislizenus found them also beyond the Rio del Norte near Monterey and Laredo, according to the reports published in 1848 by the Congress at Washington. The Rocky Mountains and their continuation to the east [west?] of Santa Fe in New Mexico, have entirely cut off this cretaceous sea. No trace of chalk was discovered either by Captain Fremont on the Columbia river, or on the Humboldt river in the wonderful "Great Basin" down to the Pacific, or yet by the observant Captains Cooke and Johnston in Sonora and California along the Rio Gila.

Nevertheless the whole of this so vastly extended chalk formation consists only of the upper beds. After very careful and accurate investigation, Sir C. Lyell decided, that in the whole of North America chalk strata from the Maestricht beds down to the gault alone occurred; and Mr. Ferdinand Römer, as the result of his highly valuable and accurate researches in Texas, goes the length of considering all the strata in that region, already so far removed from the Atlantic coast, as entirely of the upper division, and not even once touching on the gault.

This peculiarity is, however, singularly enough limited to North America alone. Even in Mexico deeper beds already appear to occur.

M. Galeotti has brought Trigoniæ from Tehuacan, on the borders of the province of Oaxaca, which he has described as *Trigonia plicatocostata*.* This *Trigonia* belongs to the division of the *Trigoniæ Scabræ* of Agassiz, and differs but slightly from *Trigonia aliformis*, Sow.

* Bulletin de Bruxelles, iii, No. 10.

The latter is however characteristic of the middle chalk, *craie chloritée*, as also of the gault. In the middle of the chief Cordillera of Anahuac, twelve French miles northwest from Tehuacan, this shell is so universally abundant and large that it may be regarded as the distinctive mark of the entire formation. One is astonished, he says, to find such immense accumulations of fossil shells, so many fragments of ammonites several feet in diameter, or of gigantic coral stems in this place, so much so that there is perhaps no other place on the surface of the globe where such an enormous mass of organic remains lies scattered over many square miles. Now this *Trigonia* appears again in South America in the mountains of Santa Fe de Bogota, from which M. von Humboldt first brought it to us. The organic remains enclosed in the strata of these mountains of Santa Fe de Bogota prove most decidedly the occurrence of the middle chalk, as I have endeavored to show in the description of Humboldt's collection of American petrifactions (Berlin, 1839), and as Alcide d'Orbigny has still more fully proved in his no less instructive than masterly work on M. Boussingault's collections. But as the cretaceous formations in New Grenada attain a thickness of more than 5000 feet, it is not surprising that the organic remains of the lower cretaceous strata, or the *neocomien*, should also be found in this place. D'Orbigny has described an *Exogyra* from Socorra, which is not distinct from the *Exogyra Couloni* of the *neocomien*. Many specimens of this same *Exogyra* were collected by the late Dr. Meyen on the declivities of the volcano of Maypo in Chili at the height of 13,000 feet, and (badly) figured.* Darwin also† found it on the Portillo Pass in the Peukenes chain, not far from Maypo, but also sixty English miles further north on the Uspalata Pass. The *Exogyra Couloni* or *aquila* is, however, a true and very decided characteristic shell for the *neocomien*.

The fossils collected by Darwin in the mountains above Copiapo, and Coquimbo in northern Chili, and those which Domeyko, Professor of Mineralogy in Coquimbo, has sent to Paris, again belong to newer cretaceous strata, and are found in part also at a distance from it beyond the great knot of transition beds which, along with older rocks, have intruded into the chain of the Andes.‡ The most remarkable of these forms is the beautiful univalve, which Humboldt first brought from San Felipe in the south of Quito, near the Amazon river, and which was figured and described by me as PLEUROTOMARIA HUMBOLDTII in the 'Petrifactions,' v. f. 26, first published in 1839. D'Orbigny, followed by Darwin, names it "*Turritella Andii*," but whether correctly is still very doubtful. It appears peculiarly characteristic of the whole southern districts of America. Darwin has found it in abundance in the strata of Coquimbo, on the Rio Claro and near Arqueros, and in like manner above Guasco and near Las Amolanos in the principal valley of Copiapo. This *Pleurotomaria* is always conjoined with

* Acta der Leopold. Academie, vol. xvii, pt. ii, p. 649, t. 27, f. 5.

† Geol. Observations on South America, 1846.

‡ "Beyond and north of the great shut in mountain-basin of Titicaca, composed of older rocks, the trias and carboniferous limestone." (Bet. über die Ver. der Kreide-Bild., p. 27.)

the *Pecten*, occurring even in the northern regions between Montan and Guancavelica in such incredible numbers, that it forms fields, nay, mountains of petrifactions, long and very generally known to the natives under the name of "*Choropampas.*" (*Pecten alatus*, Dufresnoyi, d'Orb.) It was this shell also that, in 1761, excited so great astonishment in Ulloa at the great elevation above the level of the sea, at which mountains composed of shells were seen, and this astonishment was repeated in all text-books, till it was discovered that the shells had not necessarily lived at this elevation, but might have been raised up from the depths of the sea. Since *Hippurites organisans* (D'Orb., p. 107, t. 22) occurs with the pecten-strata, it is evident that all these beds in Peru, as at Coquimbo and Copiapo, must be conjoined at least with the gault; a result which is most strikingly confirmed by an *Exogyra* which M. Domeyko has sent to Paris. This is indeed perfectly identical with the *Gryphæa* (*Exogyra*) *Pitscheri* from Texas, already described and figured by Morton, and the position of which above the gault at Friederichsberg has been very accurately ascertained by Ferdinand Römer.

Lower cretaceous strata, similar to those of Aconcagua, are nevertheless not altogether unknown in the Andes mountains near Lima. The celebrated zoologist von Tschudi has found, on the eastern declivity of the mountains, between Oroja and Yauti, near Tarma, along with many others, some perfectly characteristic neocomien shells:— *Pterocera Emerici*, (D'Orb., p. 216,) *conoidea*, Goldfs.; *Holaster dilatatus* and *Holaster complanatus* or *Spatangus retusus*, both identified by Agassiz; *Diadema Bourgeti*, also determined as such in Neufchatel; *Pecten cretosus*, Brgnt. and *Pecten quinquecostatus*.

According to this, the cretaceous formation in South America appears to be developed in an entirely different manner, in much greater thickness and variety than to the north of the Gulf of Mexico, and the agreement with the European cretaceous strata is also much more complete in the Andes. It is, however, highly remarkable, that in North America the cretaceous strata are spread out quite horizontally over immense spaces, and that they consist chiefly of clay and sand, and other slightly coherent masses. In South America we only see black limestones or compact sandstones, of such consistence, that one often believes them to be pure quartz, as between the Maranon and Lima; along with this, the strata are never horizontal, but always more or less inclined; a disturbed position which they evidently can only owe to powerful disturbing forces. There can be less doubt in regard to this, when it is seen, as Meyen informs us, that the precipitous cone of the Volcano of Maypo consists for two-thirds of its height of chalk rich in petrifactions, and that throughout the whole of Chili masses of gypsum, many thousand feet thick, surround the volcanos, and the cretaceous strata first appear quite above them. But when we leave this desolation, the chalk also has vanished. It never reaches the plain of the Pampas on the east; a chain of Devonian strata at the eastern foot of the Andes does not permit it even once to touch on the outskirts of the vast plains of the Pampas. As little can it extend westwards towards the Pacific Ocean. A considerable elevation on the mountains must be attained before it is met with. What then can in-

duce the chalk to run along, only in the direction of the high mountain ridge of the volcanos, and only in a narrow band, and never to descend into the plains!! In the whole of Brazil, in the wide regions of La Plata, Paraguay, Bolivia, the chalk is never again seen, and indeed does not exist. Is it not like a band of chalk which has been formed along the volcanic fissure of the Andes before the mountains were elevated, perhaps because the slightly concealed fissure had produced the conditions of life and existence for the cretaceous mollusca on a more extensive and easily attainable scale?

Darwin has followed the cretaceous strata to the extreme point of the continent. He saw cretaceous shells in abundance on the top of Mount Tarn 2000 feet high, near Port Famine in the Straits of Magellan, and in 53 degrees of south latitude, and consequently three degrees of latitude higher than on the Missouri. *Ancycloceras simplex*, d'Orb., and *Hamites elatior*, Sow., leave no doubt of the chalk. The Hamite is even, says Prof. Edward Forbes, one of the largest ever seen, fully 2½ inches in its largest diameter. Darwin's discovery probably determines the most southern limit of the cretaceous formations; and hence polar influences may have here also opposed its further extension towards the Pole. J. N.

III. Zoology.

1. *Contributions to the Natural History of the Acalephæ of North America;* by L. Agassiz: Part I, on the Naked-eyed Medusæ of the shores of Massachusetts in their perfect state of development, (Transactions of the American Academy of Arts and Sciences, 2nd Series, Vol. III, Part I, Article IX, pp. 221 to 316, 4to, with 8 plates.)—Professor Agassiz. in this paper, gives his readers Part I. of his researches on the Medusæ of the American Coast. His investigations have brought to light much that is new and of deep interest to science: and they are illustrated by beautiful as well as faithful engravings. The species described are *Sarsia marabilis*, *Hippocrene superciliaris*, *Tiaropsis diademata*, and *Staurophora laciniata*.

Prof. Agassiz, in the course of his memoir, makes some observations on the classification of these animals, and gives reasons for including all the naked-eyed Medusæ in one family. He points out the little importance to be attached (except for generic and specific distinctions) to the number of tentacles, and the position of the ovaries in these Medusæ. The grand characters of the group or family are as follows:—
—consisting of a gelatinous disk with the margin re-entering so as to form a cavity beneath;—a central digestive cavity, from which tubes, carrying chyme and forming a chymiferous system, radiate towards the margin and connect with or pass into a circular tube situated near the margin;—tentacles and eye-specks along this margin; mouth central but varying in size and form;—reproductive organs following the chymiferous system;—a nervous ring adjoining the submarginal chymiferous tube;—generation alternate, one form Polypoid, and the other Medusoid.

Among the species described, we select for particular notice the *Hippocrene superciliaris*, the observations on which embrace the principal points determined by the author. This beautiful Medusæ is a

globular bell-shape animal with 4 bunches of tentacles on the lower margin. In the inner cavity of the bell, at centre, there is a dark four-sided mass, containing the mouth and digestive cavity, about as broad as long. In some species, as the genus *Sarsia*, this mass is elongated into a movable proboscis, in others it is scarcely projecting. From its angles, in the Hippocrene, proceed internally four tubes which carry from the digestive cavity the chyme or fluids after digestion, diluted with more or less of the external waters; these tubes pass to the border and here connect with a circular tube which follows the margin around, and in which the chyme continues its course. This, as Prof. Agassiz explains with many details, is the circulating and digestive system combined, of this and other species of the family. The tubes may be closed at their connection with the stomach, "showing that the food is not admitted before it has undergone a certain degree of elaboration; but no sooner has it been reduced to the requisite degree of fluidity, in which the particles of the nourishing materials appear like little globules, than they open, the nutritive fluid passes into the radiating tubes, circulates regularly through these tubes along the inner walls of the disk, and through them passes into the circular tube around the lower margin." Prof. Agassiz observes that while the circulation is properly a *chyme* circulation in these animals, it is a *chyle* circulation in Articulata and Mollusca, and in Vertebrata alone, *true blood*. The particles in the circulating fluid of these Medusæ are very irregular in size and color and are evidently only the imperfectly digested food.

The *nervous cord*, as distinctly made out by Prof. Agassiz, follows the circular submarginal tube on its inner side, and like that, is a complete ring. At the base of the cluster of marginal tentacles there is an enlargement or bulb-like prominence. Each tentacle contains within its base a black point which subserves the purpose of vision. The bulb is not hollow in the Hippocrene, but contains an enlargement of the nervous cord, which, as our author shows, may be considered a ganglion, although not purely nervous matter in its constitution, and this position of the ganglion has a direct relation to the organs of sense clustered near it. The nervous cord, under a high magnifier, appeared as a string of several rows of nucleated ovate cells, ranging in irregular lines, the cells not strictly in juxtaposition by their ends, but alternate more or less, so as to form a cord-like mass; and it was distinctly observed passing into the angles of the sensitive bulbs. The dark spot of the bulb consists of pigment cells, which point to the centre of minute black eye-specks, showing a close connection between these dark dots and the centre of the bulb where the nervous ganglion is seated; "and though this is not an arrangement known in the organs of vision of any other animals, we are at least reminded by these peculiarities of the structure of the compound eye of insects, in which the pigment pillars intervening between the nervous mass at the base of the eyes present a structure not very different from that of the radiating cones in the bulb of the Hippocrene."

There is a similar ganglion in each of the four bulbs. A branch of the nervous thread, or what appeared to be a continuation of it, was detected along each chymiferous tube leading upward towards the di-

gestive cavity; and above, near where these tubes bend towards this cavity, the cord passes around so as to form a circle, about the upper part of the chymiferous system or near the centre of the disk. There is thus a marginal, and (if there be no mistake as to its nervous character,) a central circle to the nervous system; from the latter at a point half way between two chymiferous tubes a branch passes off and descends to the buccal or digestive mass below, and other branches go to the inner muscles. Professor Agassiz observes that there is a difference between the cord of the lower margin and the other threads, and he was not fully satisfied of the real nature of the latter. Instead of consisting of distinct cells, they are thin threads in which the cellular appearance is almost gone, excepting where they combine to form a plexus in which some of the threads have the form of long caudate cells: they differ from muscular fibres as much as they do from the main nervous cord. No contraction was observed in them; this fact, and also their connection with the chymiferous tubes and the sensitive bulbs below,—the nature and position of the plexuses as well as their branching to the digestive organ and to the muscles—favor the view taken. The close juxtaposition of the chymiferous system —the source of nutriment—with the nervous system and the sensitive bulbs and eye-specks, is remarked upon as a fact of much interest.

The muscular system is minutely developed in this memoir and well brought out in the figures. The muscles consist of contractile cells, rather than of fibres. Over the surface of the bell-shaped part of the disk, the epithelium consists of irregular polygonal cells, of very faint outline, hardly distinguishable except by a kind of mosaic arrangement seen by means of their granular contents. On the sides and above the disk as well as on the inner surface of the main cavity, these cells are more regular and distinct. The network of muscles, or rather lines of contractile cells, beneath the epithelium extend in two main directions; the main bundles being vertical, four in number, and alternating with the chymiferous tubes; and the others transverse circular, in four narrow ranges, but with others smaller and less regular. The fibres are chiefly superficial though penetrating somewhat into the gelatinous disk. In the inner cavity, there are four vertical muscular bundles, ranging between the chymiferous tubes, which terminate midway between the sensitive bulbs; and also eight others much smaller, alternating by twos with these four. This same cavity has a transverse layer of contractile cells lining the whole interior, as was distinctly observed on close examination. It properly consists of four parts, extending from one chymiferous tube to another. There is still another muscular system extending between the four sensitive bulbs, within the lower margin, which is made up of a thick layer of muscular fibres, with which alternate some few radiating fibres, crossing the former at right angles and most numerous about the eye-specks.

It is now well known that these Medusæ in one stage of their existence have a polyp form, and these Hydroid polyps are therefore only imperfect Medusæ. The Sarsia in one of its conditions is a *Coryna*, and the species of Coryna pertaining to the *Sarsia mirabilis* (although not figured in this memoir, which treats only of these animals in their perfect state of development) is well known in the Boston Harbor and has

been often collected by Prof. Agassiz. The polyp of the Hippocrene is still unknown: but we have here the suggestion, with some good reasons for admitting its correctness, that it is a *Tubularia*, a fine species of which is well known in the same harbor.

Many other points are detailed in this memoir which we have to pass by at this time.

Besides the species mentioned as described in this paper, the author briefly mentions two new species of *Thaumantias* (T. diaphana and T. pilosella); and also a new genus near Hippocrene which he calls *Nemopsis*, in allusion to the fact that two of the eye-specks of each cluster have a slender pedicel instead of being sessile like the others near the bases of the tentacles. The species was taken in Nantucket Harbor, June, 1849, and is named *N. Bachei.*

2. *On the Structure of Nummulina;* by W. B. Carpenter, M.D., F.R.S., (Quart. J. Geol. Soc., No. 21, Feb. 1, 1850.)—In this elaborate and well illustrated memoir, Mr. Carpenter sustains the opinion that the Nummulites are true Foraminifera. The succession of cells in a spiral order was pointed out by D'Orbigny as favoring this view. Carpenter remarks also that the cells or chambers are not even and regular as in the chambered shells of the cephalopodous mollusks, but irregular and of varying size, and hence infers that the cells must have corresponded to separate individuals, like the polyps of a compound coral zoophyte, and that they were the result of successive gemmation. The septa are found under a high lens to be double, each cell having its own proper wall. A distinct perforation passes through the septa, as observed by D'Orbigny, and still more minute apertures, varying in number and position, exist on the surface of each septum penetrating, however, only a single wall. The successive whorls of the Nummulite are well known to envelop and invest completely each the preceding, so that in a vertical section each chamber of the medial plane is seen to be covered with as many layers of shell above and below its own roof and floor, as there are chambers intervening between it and the nearest margin of the sections. A series of perforations were detected by Carpenter, extending from the exterior directly downwards until they reach the roof and floor of the central plane which they do not penetrate. They terminate over the septa and pass actually into the *interseptal spaces*, which have numerous communications with the chambers themselves. Thus there is a direct communication of a tubular character between the interseptal spaces of the central plane and the external surface, so that all these spaces communicate with the medium, which the animal may inhabit. "In the *Nummulina complanata* and other species in which each investing whorl is in contact with the one it encloses, except at its edge, the perforations have the form of fissures, that correspond with the subjacent septa, towards which they directly pass." These fissures are usually found to be filled with opake matter; and the dark bands thus formed in a transparent section are seen to be crossed by delicate white lines, which seem to indicate a division of the fissure into a number of tubes of irregular form, probably for the passage of pseudopodia. The animal segments of the several cells though distinct have a connection by fibres or tubes, and it is probable that the inner whorls retained their vitality, although so deeply inclosed,

and absorb their nourishment probably by means of filamentous pseudopodia projecting through the system of passages leading from the medial plane to the inner surface.

The memoir contains also the results of a microscopic investigation of the Orbitolites, showing their relation to the Nummulites, and also observations upon the Orbitoides, indicating that they also are Foraminifera.

IV. Miscellaneous Intelligence.

1. *On the Negro Races of Oriental Africa;* by M. Serres, (L'Institut, No. 857, June 5, 1850, from the Proceedings of the Academy of Sciences of Paris, June 3, 1850.)—M. Serres read a report on the negro races of Oriental Africa, south of the equator, observed by M. de Froberville. The conclusions of the report are as follows:—That the gradation or degradation of the physical characters of the Ostro-Negros justifies in all points the divisions which the author has laid down;—that among these characters, the prognatism of the maxillaries, the thickness and prominence of the lips, the woolly or frizzled tendency in the hair, the shades of color in the skin, are particularly and properly brought out;—that with regard to the prognatism of the maxillaries and the peculiarity of the lips "en forme de boudin," there is a regular gradation from the Congo-Guinea negro to the Eastern Oceanic negro, and from these to the Caffro-Bechuans, and these last graduate into the Semitic mongrels in those physical conditions where they are observed in some branches of the Caucasian race;—that this gradation of characters, of so much interest in the study of the races of men, is well sustained by a comparison of the busts executed by M. de Froberville, and better still by the portraits obtained by means of the daguerreotype by Dr. Jacquart;—that the existence of a type uniformly disseminated among the negro tribes distributed south of the equator to the gulf of Mozambique having close relations to the Semitic type is a fact of great interest in anthropology;—that this interest is independent of the Phenician origin which M. de Froberville attributes to it, and which at present is only an hypothesis;—that the repetition of an oceano-negro type among one of the groups of Oriental Africa is also a most curious result bearing upon the affiliation of races, in spite of the disagreement which exists in this subject between ethnology and anthropology;—that, finally, from the analysis and comparison of the physical characters of the Ostro-negros, the conclusion of the author is obvious and decisive, that "the more thoroughly and comprehensively the Congo-guinean, Caffro-bechuan and Ostro-negro races are studied, the more distinctly does the unity of the human race come out as an established principle in science.

2. *Fabrication of Zinc compounds not injurious to health.*—At a meeting of the Academy of Sciences at Paris in June last, M. Sorel, replying to some authors who at preceding sessions of the Academy had made observations tending to show that zinc was not innocuous, stated that for fifteen years he had employed in his establishments for the galvanization of iron several hundred workmen, a large number of whom were occupied with pulverizing and sifting the gray or suboxyd of zinc, for galvanic painting, and in no instance had any of the work-

men of the establishment, although in the midst of an atmosphere containing much of the oxyd, suffered at all from it. The white oxyd of zinc had also been fabricated for some months, without any ill effects, although the men breathe considerable quantities of the oxyd.

3. *Anchor-Ice;* by Prof. C. DEWEY.—Water sometimes freezes upon stones below the unfrozen surface of the water. Fastened in this way, it passes under the common name of *anchor-ice.* As soon as the ice is detached, it rises to the surface and floats upon it. In explaining this phenomenon, it has been said, that in thus freezing, the water parts with its latent caloric to the stone and crystallizes upon it, and that its crystals are then *heavier* than water. The first part of this solution is only a statement of the fact in chemical language, and the last part is opposed by the fact that the detached ice uniformly and directly rises to the surface.

The observed facts are the following. Anchor-ice forms in still or running water, and often where the current is rapid; on stones of quartz, granite, mica-slate, or limestone, and on wood fresh or old under water; in masses from less than an inch to two or three inches thick, over stones several inches in diameter as well as on smaller ones; of a spongy or fibrous appearance under the water, but composed of flat irregular crystalline plates or tables, with regular angles and terminations, cohering or strung along upon each other, exceedingly white and beautiful; when the surface of the water is free from ice, and the *temperature of the whole is at the freezing point* as shown by the thermometer, and the atmosphere is below the freezing point several degrees; when none is on the stones at sunset, they are covered in the morning after a clear and cool night. This ice begins to leave the stones in the morning, and before noon has all risen and disappeared, often covering the whole surface of the water for some time. Repeated instances of these various particulars were observed by me in the latter part of March last, in Queechy River, at Woodstock, Vt., a stream there three to six rods in width and of variable depth. The stones lay loose on the bottom, often on sand, and had no connection with rocks which sometimes extended from the bottom to air or to the frozen earth in the banks out of the water. This ice was formed all along the bottom, probably for miles where the same circumstances occurred. I saw it also on wood under water, and in one instance on a piece fresh sawed from a log of hemlock. The depth to the ice (below the surface of the water) was from a few inches to three feet, and the water sometimes nearly still and at other places in rapid motion.

The principle of this phenomenon is probably the same as the following.

Saturated solutions of some salts, as sulphate of soda, at a high temperature, may be gradually cooled at rest without depositing the salt. The agitation of the cooled solution, on putting a rod of glass, wood or metal into it, commonly, but not *always*, causes the deposition of the substance. A crystal dropped into the solution directly begins the crystallization of the salt. It is well known that water may be cooled in a still vessel below 32° without freezing, but a little agitation produces congelation of a part of the water in long fibrous or laminated crystals.

The stream of water is cooled to the freezing point, and by the cold of the night its temperature is still more reduced. In this state the caloric is more than saturated, and the stones and wood under the water perform the part of the crystals or rod in the solution of salt, and the ice forms upon them.

The quantity of anchor-ice formed would be small for an obvious reason. Every pound of water frozen would evolve 142° of caloric, which would raise 142 pounds of water one degree, or 71 pounds two degrees. Allowing the temperature of the stream to be reduced to 31° or 30°, the congelation of a relatively small quantity would thus prevent the further congelation, while the crystals of ice would be formed under water where the solid bodies, as wood or stone, are.

Considering how poor a conductor of caloric wood is, it can hardly be supposed, that anchor-ice is formed on solid bodies merely because they are better conductors of caloric than water is, and the more so, because they must have the same temperature as the water.

Rochester, July, 1850.

P. S. Rocks sometimes pass from a frozen bank, by connection with which their temperature may be as low as 20°, into and under water, which congeals on them because they are so cold, and thus forms *solid* ice. This is not a case of anchor-ice, nor has it the form of that ice. When a rock, projecting from water, congeals the water into solid ice around it, this is not *anchor-ice*. To the first of these cases is doubtless to be referred that of James River, noticed in vol. xxxvi, p. 186 of this Journal. The explanation of it in vol. xli, p. 407, will hardly be considered applicable to real anchor-ice. It is probable that some of the ice in James River may be of the kind above described, though I have never seen it in *solid* masses, but of a spongy appearance. This form the anchor-ice retains after it has risen to the surface of the water.

4. *Discovery of the Great Lake "Ngami," of South Africa;* (Letfrom the Rev. David Livingston, addressed to the Rev. Authur Tidman, Foreign Secretary, London Missionary Society; dated, Banks of the River Zonga, 3rd September, 1849; cited from Jameson's Journal, July, 1850, vol. xlix, p. 156.)—*Dear Sir*,—I left my station, Kolobeng (situated 25° South lat., 26 East long.), on the 1st of June last, in order to carry into effect the intention, of which I had previously informed you, viz., to open a new field in the north, by penetrating the great obstacle to our progress, called the Desert, which, stretching away on our west, northwest, and north, has hitherto presented an insurmountable barrier to Europeans.

A large party of Griquas, in about thirty waggons, made many and persevering efforts at two different points last year; but, though inured to the climate, and stimulated by the prospect of much gain from the ivory they expected to procure, want of water compelled them to retreat.

Two gentlemen, to whom I had communicated my intention of proceeding to the oft-reported lake beyond the desert, came from England for the express purpose of being present at the discovery, and to their liberal and zealous co-operation we are especially indebted for the success with which that and other objects have been accomplished. While waiting for their arrival, seven men came to me from the Batavana, a

tribe living on the banks of the lake, with an earnest request from their chief for a visit. But the path by which they had come to Kolobeng was impracticable for waggons; so, declining their guidance I selected the more circuitous route, by which the Bermangueato usually pass, and, having Bakwains for guides, their self-interest in our success was secured by my promising to carry any ivory they might procure for their chiefs in my waggon; and right faithfully they performed their task.

When Sekhomi, the Bermangueato chief, became aware of our intentions to pass into the regions beyond him, with true native inhumanity he sent men before us to drive away all bushmen and Bakalihari from our route, in order that, being deprived of their assistance in the search for water, we might, like the Griquas above mentioned, be compelled to return This measure deprived me of the opportunity of holding the intercourse with these poor outcasts I might otherwise have enjoyed. But through the good providence of God, after travelling about 300 miles from Kolobeng, we struck on a magnificent river on the 4th of July, and without farther difficulty, in so far as water was concerned, by winding along its banks nearly 300 miles more, we reached the Batavana, on the lake Ngami, by the beginning of August.

Previous to leaving this beautiful river on my return home, and commencing our route across the desert, I feel anxious to furnish you with the impressions produced on my mind by it and its inhabitants, the Bakoba or Bayeiye. They are a totally distinct race from the Bechuanas. They call themselves Bayeiye (or men), while the term Bakoba (the name has somewhat of the meaning of "slaves,") is applied to them by the Bechuanas. Their complexion is darker than that of the Bechuanas; and of 300 words I collected of their language, only 21 bear any resemblance to Sitchuana. They paddle along the rivers and lake in canoes hollowed out of the trunks of single trees; take fish in nets made of a weed which abounds on the banks; and kill hippopotami with harpoons attached to ropes. We greatly admired the frank, manly bearing of these inland sailors. Many of them spoke Sitchuana fluently, and, while the waggon went along the bank, I greatly enjoyed following the windings of the river in one of their primitive craft, and visiting their little villages among the reed. The banks are beautiful beyond anything we had ever seen, except perhaps some parts of the Clyde. They are covered, in general, with gigantic trees, some of them bearing fruit, and quite new. Two of the Boabab variety measured 70 to 76 feet in circumference. The higher we ascended the river, the broader it became, until we often saw more than 100 yards of clear deep water between the broad belt of reed which grows in the shallower parts. The water was clear as crystal, and as we approached the point of junction with other large rivers *reported to exist* in the north, it was quite soft and cold. The fact that the Zonga is connected with large rivers coming from the north awakens emotions in my mind, which make the discovery of the lake dwindle out of sight. It opens the prospect of a highway, capable of being quickly traversed by boats, to a large section of well-peopled territory.

One remarkable feature in this river is its periodical rise and fall. It has risen nearly three feet in height since our arrival, and this is the

dry season. That the rise is not caused by rains is evident from the water being so pure. Its purity and softness increased as we ascended towards its junction with the Tamunakle, from which, although connected with the lake, it derives the present increased supply. The sharpness of the air caused an amazing keenness of appetite, at an elevation of little more than 2000 feet above the level of the sea (water boiled at 207½° thermometer), and the reports of the Bayeiye, that the waters came from a mountainous region, suggested the conclusion that the increase of the water, at the beginning and middle of the dry season, must be derived from melting snow.

All the rivers reported, to the north of this, have Bayeiye upon them, and there are other tribes on their banks. To one of these, after visiting the Batavana, and taking a peep at the broad part of the lake, we directed our course; but the Batavana chief managed to obstruct us, by keeping all the Bayeiye near the ford on the opposite bank of the Zonga. African chiefs invariably dislike to see strangers passing *them to tribes beyond.* Sebitoane,—the chief who in former years saved the life of Sechele *our* chief,—lives about ten days northeast of the Batavana. The latter sent a present as a token of gratitude. This would have been a good introduction; the knowledge of the language, however, is the *best* we can have. I endeavored to construct a raft, at a part which was only fifty or sixty yards wide, but the wood, though sun-dried, was so heavy it sunk immediately; another kind would not bear my weight, although a considerable portion of my person was under water. I could easily have swam across, and fain would have done it; but, landing without clothes, and then demanding of the Bakoba the loan of a boat, would scarcely be the thing for a messenger of peace, even though no alligator met me in the passage. These and other thoughts were revolving in my mind as I stood in the water,—for most sorely do I dislike to be beaten,—when my kind and generous friend Mr. Oswell, with whom *alone* the visit to Sebitoane was to be made, offered to bring up a boat at his own expense from the Cape, which, after visiting the chief, and coming round the north end of the lake, will become missionary property. To him and our other companion, Mr. Murray, I feel greatly indebted,—*for the chief expense has been borne by them. They* could not have reached this point without my assistance; but, for the aid they have rendered in opening up this field, I feel greatly indebted; and, should any public notice be taken of this journey, I shall feel obliged to the directors if they express my thankfulness.

The Bayeiye or Bakoba listened to the statements made from the Divine Word with great attention, and if I am not mistaken, seemed to understand the message of mercy delivered better than any people to whom I have preached for the *first* time. They have invariably a great many charms in the villages; stated the name of God in their language (without the least hesitation) to be "Oreeja;" mentioned the name of the first man and woman, and some traditionary statements respecting the flood. I shall not, however, take these for certain, till I have more knowledge of their language. They are found dwelling among the reed all around the lake, and on the banks of all the rivers to the north.

With the periodical flow of the rivers great shoals of fish descend. The people could give no reason for the rise of the water, further than

that a chief, who lives in a part of the country in the north, called Mazzekiva, kills a man annually and throws his body into the stream, after which the water begins to flow.

The sketch which I enclose is intended to convey an idea of the river Zonga and the lake Ngami. The name of the latter is pronounced as if written with the Spanish ñ, the *g* being inserted to show that the ringing sound is required. The meaning is "Great Water." The latitude, taken by a Sextant on which I can fully depend, was 20° 20′ south, at the northeast extremity, where it is joined by the Zonga; longitude about 24° east. *We do not, however, know it with certainty.* We left our waggon near the Batavana town, and rode on horseback about six miles beyond it to the broad part. It gradually widens out into a Firth about 15 miles across, as you go south from the town, and in the south-southwest presents a large horizon of water. *It is reported* to be about 70 miles in length, bends round to the northwest, and there receives another river similar to the Zonga. The Zonga runs to the northeast. The thorns were so thickly planted near the upper part of this river, that we left all our waggons standing about 180 miles from the lake, except that of Mr. Oswell, in which we traveled the remaining distance; but for this precaution our oxen would have been unable to return. I am now standing at a tribe of Bakurutse, and shall in a day or two re-enter the desert.

The breadth marked is intended to show the difference between the size of the Zonga, after its junction with the Tamunakle and before it. The farther it runs east, the narrower it becomes. The course is shown by the arrow-heads. *The rivers not seen, but reported by the natives*, are put down in dotted lines. The dotted lines running north of the river and lake, show the probable course of the Tamunakle, and another river which falls into the lake at its northwest extremity. The arrow-heads show also the direction of *its* flow. At the part marked by the name of the Chief Mosing it is not more than 50 or 60 yards in breadth, while at 20° 7′ it is more than 100, and very deep.

The principal disease reported to prevail at certain seasons appears, from the account of the symptoms the natives give, to be pneumonia and not fever. When the wind rises to an ordinary breeze, such immense clouds of dust arise from the numerous dried-out lakes called salt-pans, that the whole atmosphere becomes quite yellow, and one cannot distinguish objects more than two miles off. It causes irritation in the eyes, and, as wind prevails almost constantly at certain seasons, this impalpable powder may act as it does among the grinders in Sheffield. We observed cough among them, a complaint almost unknown at Kolobeng. Musquitoes swarm in summer, and the Banyan and Palmyra give in some parts an Indian cast to the scenery.

(Signed) DAVID LIVINGSTON.

5. *Comparison of Fahrenheit and Centigrade Thermometers;* (L'Institut, No. 854, Acad. Sci., Paris.)—M. A. d'Abbadie observes that the usual formula for comparing Fahrenheit and Centigrade thermometers, $\left(C=\frac{(F-32°)\times 100}{180}\right.$, when C and F represent respectively the degrees of the two thermometers,) supposes that 180° Fahrenheit just equals

100° of Centigrade; but in France the height of the barometer for graduation is 760 millimeters, while in England it is 30 inches, equivalent to 761·9862 millimeters. The Centigrade scale corresponding to 212° Fahrenheit is therefore 100·0727 degrees.

To this correction there is still another, (for instruments made at London and Paris,) amounting to $\frac{1}{10}$th of the preceding, which depends on the difference in the intensity of gravity at London and at Paris. Representing by G the force of gravity at Paris, and by g that at London, and deducing G and g from the observed length of the pendulum, we have, Log. $\frac{G}{g} = -1{\cdot}998797$. We hence obtain 759·785 millimeters for the height of the barometer at zero in London. The difference is equal to 0·215 millimeters or 0·0079 degrees.

These two corrections being applied, the Parisian scale should stand at 100·08066 degrees, when the London scale marks 212 degrees. The formula then becomes $C = \frac{(F-32°)\times 100{\cdot}08066}{180}$.

The correction is small; but in exact observations, the thermometer is read to 0·08 degrees; and it is desirable that even a slight error should not be added to errors of observation.

6. *Discovery of an Infusorial Stratum in Florida;* by Prof. J. W. Bailey.—While on a visit to Tampa (Fort Brooke), Florida, I noticed on the shores of Hillsborough Bay, between the mouth of Hillsborough River and Ballast Point, a white crumbling rock, which by its lightness, friability and other characters, somewhat resembled the Infusorial Marls of Virginia. An examination made upon the spot with a common Coddington lens enabled me to see small circular discs upon the freshly fractured surfaces, which subsequent examinations proved to belong to the genus Coscinodiscus. Numerous other marine species of Navicula, Gallionella, &c., together with numerous spicules of Sponges were recognized, although the highly indurated or lapidified condition of the strata rendered the determination of the species more than usually difficult. Of the precise geological position of this deposit I cannot be certain, but it is associated with strata containing fossils which appear to belong to the epoch of the eocene tertiary. This discovery of an extensive infusorial bed in a region so remote from those previously noticed in Virginia and Maryland, and apparently in an older geological formation will, it is hoped, lead to the examination of other localities, as it is not improbable that the deposit near Tampa may be a portion of a deposit as remarkable as those discovered by Prof. W. B. Rogers in Virginia and Maryland.

7. *On the Application of Magnetism as a Motive Power;* by R. Hunt, (Proc. Society of Arts, Athenæum, No. 1179, p. 588.)—In this paper the author called attention, in the first place, to the numerous attempts which have been made to apply electro-magnetism as a power for moving machines, and particularly described the apparatus employed by Jacobi, Dal Negro, M'Gauley, Wheatstone, and others, noticing incidentally the machines recently constructed by Mr. Hjorth. Since, notwithstanding the talent which has been devoted to this interesting subject, and the large amount of money which has been spent in the

construction of machines, the public are not in possession of any electro-magnetic machine which is capable of exerting power economically; and finding that, notwithstanding the aid given to Jacobi by the Russian Government, that able experimentalist has abandoned his experimental trials,—the author has been induced to devote much attention to the examination of the first principles by which the power is regulated, with the hope of being enabled to set the entire question on a satisfactory basis. The phenomenon of electro-magnetic induction was explained, and illustrations given of the magnetization of soft iron by means of a voltaic current made to circle around it. The power of electro-magnets was given, and the author stated his belief that this power could be increased without limitation. A voltaic current produced by the chemical disturbance of the elements of any battery, no matter what its form may be, is capable of producing by induction a magnetic force, *this magnetic force being always in an exact ratio to the amount of matter (zinc, iron, or otherwise) consumed in the battery.* Several forms of the voltaic battery were explained, particularly those of Daniell, Grove, Bunsen, and Reinsch, the latter being constructed without metals, depending entirely on the action between two dissimilar fluids, slowly combining. The author had, however, proved, by an extensive series of experiments, that the greatest amount of magnetic power is produced when the chemical action is most rapid. Hence, in all magnetic machines, it is more economical to employ a battery in intense action, than one in which the chemical action is slow. It has been proved by Mr. Joule, and most satisfactorily confirmed by the author, that one-horse power is obtainable in an electro-magnetic engine, the most favorably constructed to prevent loss of power, at the cost of 45 lb. of zinc, in a Grove's battery, in twenty-four hours; while 75 lb. are consumed in the same time to produce the same power in a battery of Daniell's construction. The cause of this was referred to the necessity of producing a high degree of excitement, to overcome the resistance which the molecular forces offer to the electrical perturbations, on which the magnetic force depends. It was contended, that although we have not perhaps arrived at the best form of voltaic battery, yet that we had learnt sufficient of the law of electro-magnetic forces to declare that, under any conditions, the amount of magnetic power would depend on the change of state—consumption of an element—in the battery, and that the question resolved itself into this:—

What amount of magnetic power can be obtained from an equivalent of any material consumed? The following were regarded as the most satisfactory results yet obtained:—1. The force of voltaic current being equal to 678, the number of grains of zinc destroyed per hour was 151, which raised 9,000 lb. one foot high in that time. 2. The force of current being, relatively, 1,300, the zinc destroyed in an hour was 291 grains, which raised 10,030 lb. through the space of one foot. 3. The force being 1,000, the zinc consumed was 223 grains; the weight lifted one foot 12,672 lb. The estimations made by Messrs. Scoresby and Joule, and the results obtained by Oersted, and more recently by Mr. Hunt, very nearly agree; and it was stated that one grain of coal consumed in the furnace of a Cornish engine lifted 143 lbs. one foot high, whereas one grain of zinc consumed in the battery

lifted only 80 lbs. The cost of 1 cwt. of coal is under 9*d.*; the cost of 1 cwt. of zinc is 216*d.* Therefore, under the most perfect conditions, magnetic power must be nearly 25 times more expensive than steam power. But the author proceeded to show that it was almost proved to be an impossibility ever to reach even this, owing, in the first place, to the rate with which the force diminishes through space. As the mean of a great many experiments on a large variety of magnets, of different forms and modes of construction, the following result was given:—

Magnet and armature in contact, lifting force	. .	220 lb.
" distant $\frac{1}{250}$ of an inch	. .	90·6
" " $\frac{1}{125}$ "	. .	50·7
" " $\frac{1}{83}$ "	. .	50·1
" " $\frac{1}{50}$ "	. .	40·5

Thus at one-fiftieth of an inch distance four-fifths of the power are lost. This great reduction of power takes place when the magnets are stationary. The author then proceeded to show that the moment they were set in motion a great reduction of the original power immediately took place; that, indeed, any disturbance produced near the poles of a magnet diminished, during the continuance of the motion, its attractive force. The attractive force of a magnet being 150 lb. when free of disturbance, fell to one-half, by occasioning an armature to revolve near its poles. Therefore, when a system of magnets which had been constructed to produce a given power is set in revolution, every magnet at once suffers an immense loss of power, and consequently their combined action falls in practice very far short of their estimated power. This fact has not been before distinctly stated, although the author is informed that Jacobi observed it. And not merely does each magnet thus sustain an actual loss of power, but the power thus lost is converted into a new form of force, or rather becomes a current of electricity, acting in opposition to the primary current by which the magnetism is induced. From an examination of all these results, Mr. Hunt is disposed to regard electro-magnetic power as impracticable, on account of its cost, which must necessarily be, he conceives, under the best conditions, fifty times more expensive than steam power, and is at present at least 150 times as expensive.*

8. *Improvements in the Air-pump;* by Mr. Varley, Jr., (Athenæum.)—In place of the two barrels and vibrating intermittent motion of the ordinary pump, Mr. Varley has a continuous circular motion in the handle, and one double-acting barrel. The piston-rod is attached to a crank on the motion shaft, and the cylinder oscillates from its bottom, a packed joint being done away with by having the tube between the barrel and the receiver coiled spirally, which, by its spring, gives play enough for oscillation of the barrel. Mr. Varley explained his larger pump, in which there are some contrivances in addition to those already mentioned. Instead of a valve opening inwards into the barrel by the pressure of the air, as in the old pumps, the valve is worked by an eccentric, and is so arranged as to open a communication between

* A new invention by Prof. Page, described at the recent meeting of the American Association, sets aside entirely this calculation; the whole expenditure for the zinc consumed in producing with his machine 1 horse power for 24 hours, is 20 cents.

the top and the bottom of the barrel at each stroke, by which the rarefaction of the air is doubled. He has obtained, with this pump, a vacuum of $\frac{1}{15}$ of an inch of mercury.

9. *On Photography on Glass;* by T. A. Malone, (Athenæum, No. 1179, p. 589.)—In repeating the experiment of M. Niepce de Saint-Victor on photography on albumen (published in the *Technologiste* for 1848,) I was led to devise a plan of my own for making "glass negatives." I proceeded as follows:—To the white of an egg its own bulk of water was added; the mixture beaten into a froth was then put into a strainer made of letter-paper so twisted as to form a cone, having a small aperture at its apex; pinned near the base to hold the paper to its shape. The clear diluted albumen soon passed through into a wide-mouthed bottle, which answered the double purpose of a receptacle for the fluid and a support to the cone. A piece of plate-glass, thick or thin, as you please, was then rubbed with a solution of caustic alkali, washed in water, and dried with a cloth: just before applying the albumen, the glass was breathed upon and rubbed with new blotting-paper; then, to remove dust and fibres, cotton wool was used. Unless this latter and every other precaution is taken to prevent dust, the picture will be full of spots produced by a greater absorption of iodine (in a subsequent process) in those than in the surrounding parts.

Now pour the albumen on the glass, inclining the plate from side to side until it is covered; allow the excess to run off at one of the corners, keeping the plate nearly vertical. As soon as the albumen ceases to drop rapidly, breathe on, or warm the lower half of the plate; the warmth and moisture of the breath will soon cause it to part with more of its albumen; wiping the edges constantly hastens the operation.

Until this plan was adopted, the coatings were seldom uniform; the upper half of the plate retained less albumen than the lower,—of course care must be taken to warm only the lower half. When no more albumen runs down, dry the plate. I use for this purpose a double-ring gas-burner of some eighty jets. A common fire answers as well, save now and then it imparts a little dust.

The film, when dry, is quite free from cracks, and is so thin and transparent that the brilliancy of the glass is unimpaired. It is almost necessary to mark it to know which side has been coated.

The next operation is to iodize the plate. Dilute pure iodine with dry white sand in a mortar, using about equal parts of each. Put this mixture into a square glass trough, and over it place the albumined plate; as soon as the latter has become yellow in color, resembling beautiful stained glass, remove it into a room lighted only by a candle, or through any yellow translucent substance—yellow calico, for instance. Here plunge it vertically and rapidly into a deep narrow vessel containing a solution of "aceto-nitrate" of silver, made by adding three ounces of nitrate of silver to two ounces of glacial acetic acid, diluted with sixty ounces of distilled water. Allow it to remain until the transparent yellow tint disappears, to be succeeded by a milky-looking film of iodid of silver. Washing with distilled water completes this operation. The plate is now ready for the camera. After it has been submitted to the action of the light pour over its surface a saturated solution of gallic acid. A negative Talbotype image on al-

bumen is the result. Washing with water before and after immersion, in a solution of one part of hyposulphite of soda in 16 parts of water, until the yellow tint is removed from the shadows, completes the process.

But where is the novelty? Let us go back a step. While the gallic acid is developing its reddish-brown image, pour upon the surface a strong solution of nitrate of silver:—the brown image deepens in intensity until it becomes black. Another change commences: the image begins to grow lighter, and, by perfectly natural magic, finishes by converting the black into white, presenting the curious phenomenon of the conversion of a Talbotype *negative* into, apparently, a Daguerreotype *positive*, but by very opposite agency, no mercury being present;—metallic silver (probably) here producing the lights, while in the Daguerreotype it produces the shades of the picture. I have said probably, because it may be unwise to speculate chemically upon appearances which may depend solely on molecular arrangement:—an intricate subject, to which I hope this communication may prove a slight contribution.

Prof. Wheatstone has suggested to me the desirableness of substituting blackened wood or blackened ivory for glass plates; we should probably then have the novelty of a Daguerreotype on wood free from some of the disadvantages attendant on polished metal. Mr. Cundall suggests the application of it to wood blocks for wood engravers for certain purposes, making the drawings by light instead of by hand.

10. *Lead Statuary;* (Athenæum, No. 1176, p. 511.)—I doubt not every true lover of art will feel grateful to your Edinburgh correspondent for his excellent letter on the subject of the fitness of lead as an economical and most perfect substitute for bronze or other costly material for statuary and other sculptural works of art.

I trust the subject which he has brought before your readers will receive all due attention from those who practice, as well as from those who desire to encourage, this noble department of art.

The object which I have in view in intruding on your attention on this occasion is to confirm, as a practical man, the perfect fitness of lead as a substitute for all such works of art as have hitherto been executed in bronze or marble; and to add that, owing to the comparatively low temperature at which lead melts, and the ease and perfection with which it can be cast into the most intricate and delicate forms, our artists may resume that admirable system of casting groups of statuary and other complex sculptural designs which was in use during the finest periods of Greek and Italian art,—namely, by the employment of wax as the material for the original work, which yields such perfect facility for the execution—and when completed coating or enveloping the wax original in plaster of Paris, and then melting out the wax, and so leaving a most perfect mould, be the intricacy or complexity of the original ever so great. By this mode our artists may revel in the most difficult "undercutting," and be certain to bring forth a metal casting as sharp and perfect in all the integrity of its parts and minute details as was the original.

The addition of about five per cent. of *antimony* to the lead will give it not only great hardness, but enhance its capability to run into the

most delicate details of the work. As to the durability of the lead for such works of art, any one who has observed the next to no waste which has taken place in lead exposed on the roofs of ancient buildings, will have in this way most abundant and satisfactory proof that it is in every sense of use as durable a material as bronze when subject simply to atmospheric action.

It would give me pleasure to enumerate several practical details in respect to the employment of lead for the purposes in question,—as also to detail the process of moulding hollow statues, &c.,—should you or any of your readers think such information worthy of your attention. I am, &c. JAMES NASMYTH.

11. *British Association.*—The British Association commenced its twentieth Meeting at Edinburgh on Wednesday, July 31. By Wednesday night 900 names had been recorded, and the receipts amounted to £814. At the first meeting, Wednesday night, Sir David Brewster, the President for the session, addressed the Association.

12. *Sun and Moon;* (L'Institut, No. 857.)—M. NIEPCE DE ST. VICTOR has obtained images of the sun and moon on beds of albumen rendered sensible by an accelerative process peculiar to it. These photographic experiments confirm the opinion before stated by MM. Fizeau and Foucault, that the centre of the sun gives out rays of a greater photogenic power than those of the sides.

13. *On a cloud of dust which obscured the sun for two days in Russia, on the 29th and 30th of April, 1840, during a clear sky and quiet weather;* by EHRENBERG, (Monatsb. Berlin Acad., Jan., 1850.)—This powder was furnished Ehrenberg by M. Eichwald. Microscopic examination brought to light 49 animal forms, soft portions of plants, a few crystals, a morpholite and some sand. This powder is distinguished from that of the trade winds by some prominent forms. Ehrenberg believes that there is reason for concluding that this meteoric powder is neither a terrestrial powder nor simple volcanic cinders.

14. *American Zoological Journal.*—We take pleasure in announcing the speedy appearance of a Zoological Journal at Cambridge (Massachusetts), under the direction and editorship of Prof. Agassiz. Zoologists will hail it with great pleasure, and all interested in science will be rejoiced that it is in hands so able. Its memoirs will bear upon whatever pertains to animal life, its development, anatomical structure, physiological relations, &c., and hence those who may find profit in its pages are numerous throughout this as well as other countries. It will mark the progress of this department of science over the world, and each number therefore will be laden with new truths from the most recent studies of animal life, at home and abroad. The editor is so well known for his own profound researches and original discoveries, that a word from us on this point would be superfluous.

15. *Discovery of the Antarctic Continent.*—This discovery, alluded to on page 137, was made in the winter of 1839–1840, in January, 1840, and not 1839. The French made their first discovery on the afternoon of the 19th of January, *three days* after the observation mentioned on the page referred to.

16. *Meeting of the American Association for the Advancement of Science at New Haven.*—This session commenced on the 19th of Au-

gust and was continued through the week with great zeal and interest. Prof. A. D Bache, Superintendent of the U. S. Coast Survey, was president of the meeting. The number in attendance was larger than ever before, and the papers offered covered a wide range of subjects. The meeting was subdivided into three Sections—"General Physics and Mathematics"—"Geology and Natural History," and "Chemistry and Mineralogy." A general meeting was held for an hour morning and afternoon, and in the evening a session of a more popular character, at which time addresses and discussions were heard. Prof. Henry, Secretary of the Smithsonian Institute, and President of the Cambridge Meeting, delivered his address on Thursday evening. As this noble discourse will be published in full, it is unnecessary to say more than that it contained a most admirable review of ethics for science and was peculiarly fitted for the present period of scientific progress. The next *annual* meeting of the Association will be held at Albany on the 3d Monday of August, 1851, and the semi-annual meeting on the 1st Monday of May next, at Cincinnati. Prof. L. Agassiz is the President and Prof. W. B. Rogers, General Secretary, of the year. Prof. Spencer F. Baird, of the Smithsonian Institute, was appointed permanent Secretary, and charged with the publication of the proceedings and scientific correspondence. Professor Bache gave, as President of the Charleston Meeting, an interesting sketch of that session held in March last.

NATURAL HISTORY AND GEOLOGY.

On the position and character of the Reptilian Footprints in the Carboniferous Red Shale formation of Eastern Pennsylvania. By Prof. H. D. Rogers, Boston.

On the coal formation of the United States, and especially in Pennsylvania. By Prof. Henry D. Rogers.

On the connection of the deposits of common salt with climate. By Prof. Henry D. Rogers.

On the decomposition of Rocks and Minerals by water impregnated with carbonic acid. By Profs. W. B. Rogers, and H. D. Rogers.

Tertiary Fossils of Marshfield. By Dr. C. T. Jackson.

On ancient Pot-holes in Rocks. By Dr. C. T. Jackson.

The genus Amia, a true living representative of the old family of Cœlacanthi. By L. Agassiz, Harvard.

On the age of the metamorphic rocks of Eastern Massachusetts. By Prof. L. Agassiz.

Comparison between the young caterpillars of Lepidoptera and the adult Larvæ of Musquitoes, and on the mode of formation of Stigmata. By Prof. L. Agassiz.

Remarks upon the care which certain fishes take of their young. By Prof. L. Agassiz.

On the development of compound organs from single cells. By Prof. L. Agassiz.

Singular development of the liver, air-bladder and kidneys in Siluridæ. By Prof. L. Agassiz.

On the development of compound eyes in Articulata. By Prof. L. Agassiz.

On some points in the structure of Scleroderms and Gymodonts. By Prof. L. Agassiz.

On the structure of the mouth in Crustacea. By Prof. L. Agassiz.

On the differences of Structure of Cells in Animals and corresponding differences in their functions. By Prof. L. Agassiz.

Comparison of the face of fishes with that of other Vertebrata and Man. By Professor L. Agassiz.

On the relation between coloration and structure in the higher animals. By Prof. L. Agassiz.

On the growth of the Egg, prior to the development of the embryo. By Prof. L. Agassiz.

On a new type of scales in Fishes. By Prof. L. Agassiz.

On a fossil species of Walrus found by Prof. Fraser on the shores of New Jersey. By Prof. L. Agassiz.

On the probable age of the Moa Bone Beds of New Zealand. By Reginald N. Mantell, C. E.

Notice of the discovery of a portion of the upper jaw of the Iguanodon with teeth in their natural position. By Reginald N. Mantell.

Relations of terrestrial Mollusca in Jamaica—gradation of species into each other. By Prof. C. B. Adams, Amherst College.

On the nature and origin of the species of terrestrial Mollusca, in the Island of Jamaica. By Prof. C. B. Adams.

Suggestion on changes of level in North America, during the drift period. By Prof. C. B. Adams.

On the value of Shells of Mollusca as furnishing distinctive characters. By Prof. C. B. Adams.

Curious growth of a Potato. By S. Webber.

Essay on the classification of Nemertes and Planariæ. By Charles Girard, Cambridge.

On a new Generic Type in the class of worms. By Chas. Girard.

On a new American Saurian Reptile. By Chas. Girard.

On the early uses of the metals as a medium of exchange. By J. H. Gibbon.

On the Volcanoes of central America, with observations on the Geographical and Topographical features of Nicaragua. By E. Geo. Squier.

Some observations on the gold formation of Maryland, Virginia and N. Carolina. By Prof. W. R. Johnson, Washington.

On the coal formation of Central North Carolina. By Prof. W. R. Johnson.

Researches on the origin, development, and nature of the spermatic particles throughout the Vertebrata. By Dr. W. J. Burnett, Boston.

On the Vibriona of Ehrenberg, not Animals, but Plants. By Dr. W. J. Burnett.

On Utricles as the primordial forms of all animal tissues. By Dr. W. J. Burnett.

On the relation of the distribution of Lice to the different Faunæ. By Dr. W. J. Burnett.

Notice of the habits of Ploiaria brevipennis. By Rev. Thomas Hill.

Notice of observations on drift Striæ in New Brunswick. By Prof. James Robb, Fredericton, N. B.

On the Taconic system. By T. S. HUNT, Montreal.

On some localities of Magnesite with remarks on its connection with the origin of Serpentine. By T. S. HUNT.

On the Cylindrical Structure observed in Potsdam Sandstone. By FRANKLIN B. HOUGH, Somerville, N. Y. Read by Prof. C. U. SHEPARD.

Remarks on the Geology of Mackinac, Drummond of St. Joseph's Islands and the northern shores of Lake Michigan. By Prof. JAMES HALL.

Remarks on the seventeen year Locust. By Miss MORRIS.

On the theories of the Deluge in reference to the Ethnographic distribution of the human race. By J. P. LESLEY.

On the optical characters of American Micas. By Prof. B. SILLIMAN, Jr.

On the origin of a curious spheroidal structure in certain sedimentary rocks. By Professor B. SILLIMAN, Jr.

On the analogy between the mode of reproduction in plants and the alternating generations of some Radiata. By Prof. JAMES D. DANA, Yale.

Description of the new genera of Plants found by Col. Fremont in California. By Dr. TORREY.

Fossil Coniferous Wood from the Devonian strata of Lebanon, Marion Co., Ky. By Prof. GEORGE C. SCHAEFFER. Read by Dr. W. J. BURNETT.

PHYSICS AND MATHEMATICS.

On the origin and classification of Mechanical Powers. By Prof. JOSEPH HENRY, Secretary of the Smithsonian Institution.

Analysis of the Dynamic Phenomena of the Leyden Jar. By Prof. HENRY.

On the fundamental principles of Dynamics. By Prof. BENJAMIN PIERCE, Harvard.

On the probable period of the fundamental star *a* Virginis. By Prof. B. PEIRCE.

On galvanic wave time. By R. CULMANN, Bavaria.

Description of an instrument for exhibiting the mode of vibration in a molecule of unpolarized light. By Prof. E. S. SNELL, Amherst.

On Lunar distances. By Prof. W. M. CHAUVENET, of the U. S. Naval Academy.

Description of the Tidal observations at Cat Island in the Gulf of Mexico. By Prof. A. D. BACHE, Superintendent U. S. Coast Survey.

On the modes adopted in the Coast Survey, for Charts of Currents. By Prof. A. D. BACHE.

On the use in the Coast Survey, of the Zenith Telescope, by Talcott's method, and the discussion of the observations. By Prof. A. D. BACHE.

On the late periodical visitation of the Aurora Borealis. By Prof. D. OLMSTED.

Cause of the sudden disappearance of the ice of Lake Champlain. By Prof. D. OLMSTED.

On certain points of electrical theory. By Prof. D. OLMSTED.

On some peculiar properties of a compound of Lard and Rosin. By Prof. D. OLMSTED.

Notice of a powerful Magnet. By Prof. B. Silliman, Jr.

On the optical moving of figures. By Prof Elias Loomis, New York University.

On electrical phenomena observed in certain houses. By Prof. Loomis.

On the continuance of the Magnetic and Meteorological Observations at the Toronto Observatory. By Prof. Loomis.

Some remarks on the theory of the solar spots. By Prof. H. D. Rogers, Boston.

On the theory of Storms. By Dr. Hare.

On the use of the zenith telescope in the determination of Latitude. By Prof. Lewis R. Gibbes, Charleston, S. C.

Description of a new instrument for measuring the angle contained between the optic axes of crystals, and for goniometrical purposes. Accompanied by the angles contained between the optic axes of some American Micas. By W. P. Blake, Yale Laboratory.

On the extension of Bode's Law. By Prof. Stephen Alexander, Princeton.

On the law of the induction of an electrical current upon itself. By Mr. J. H. Lane, Patent Office.

On a Whirlwind produced by the burning of a Cane-brake in Alabama. By Alexander Fisher Olmsted, New Haven.

On Monsoons on the shores of the North Atlantic. By Prof. J. H. Coffin.

On the apparent necessity for revising the received systems of Dynamical Meteorology. By W. C. Redfield, New York.

Communications on the Solar Eclipse of July, 1851. By Lieut. C. H. Davis, Supt. of the Nautical Almanac.

On the numerical computation of the co-efficients of the perturbatory function of Planetary motion. By Sears C. Walker.

On Barometrical measurements and the distance to which corresponding observations may be used for that purpose. By Prof. Arnold Guyot, Cambridge.

On a system of Meterological Observations established in the State of New York by order of the Regents of the University, in connection with, and according to the direction of, the Smithsonian Institute. By Prof. Arnold Guyot.

On the velocity of the galvanic Current in the Telegraph wires. By Dr. B. A. Gould, Jr.

On the Astronomical Journal. By Dr. B. A. Gould, Jr.

Method of ascertaining the velocity of the Galvanic current. By Orange Judd, Yale Analytical Laboratory.

Scientific interest of the proposed Industrial Exhibition at London in 1851. By W. R. Johnson.

On the influence of temperature on the absorption of light. By Prof. Wolcott Gibbs, New York.

On a mode of effecting the Achromatism of the Telescope by Lenses of the same dispersive power. By G. P. Bond, Harvard.

Notes on the progress of the determinations of the difference of Longitude between Greenwich and Cambridge, for the Coast Survey, by W. C. Bond, Director of Cambridge Observatory. By G. P. Bond, Cambridge.

On the variation in the proper motion of the fundamental star *a* Virginis. By Mr. E. SCHUBERT of Cambridge.

On a new method of observing and recording astronomical R. A. and N. P. distances. By Prof. O. M. MITCHEL, Cincinnati.

On the Laws of Perfect Musical Intonation, and their application to the Church Organ. By H. W. POOLE.

A plan for stereotyping Catalogues of Libraries by separate titles, and for forming a general stereotype Catalogue of public Libraries of the United States. By C. C. JEWETT, Assistant Sec. and Librarian of the Smithsonian Institute.

On the Nautical Almanac. By CHARLES H. DAVIS, Superintendent of the Nautical Almanac.

Elliptical Tables of the Planet Neptune. By Prof. GEORGE W. COAKLEY, St. James College, Maryland.

CHEMISTRY AND MINERALOGY.

Account of six new Mineral species. By Prof. CHARLES U. SHEPARD.

Notice of Foreign Meteorites and of a large stone lately found, of the Linn Co. fall, Missouri, Feb. 7, 1847. By Prof. C. U. SHEPARD.

Some notices of American Minerals. By Prof. CHARLES U. SHEPARD.

On the absorption of Carbonic Acid by acids and saline solutions. By Profs. W. B. ROGERS and R. E. ROGERS.

On a new method of decomposing silicates in the process of analysis, with an analysis of the Pink Scapolite of Bolton. By HENRY WURTZ, New York.

On the availability of the Green Sand of New Jersey, as a source of potash and its compounds. By HENRY WURTZ.

On the Troostite of New Jersey. By HENRY WURTZ.

On Canadian localities of Ilmenite and Chromic Iron, with remarks upon the association of these minerals with the Gold of Canada and California. By T. S. HUNT, Canada Geol. Commission.

On the analysis of Soils and the ashes of Peat. By T. S. HUNT.

On the determination of Phosphoric Acid. By T. S. HUNT.

On a locality of Asphaltum and its origin. By T. S. HUNT.

On artificial Crystals of Sesquioxyd of Chromium ($\dot{C}r_2$) with some observations on their formation. By W. P. BLAKE, Yale Laboratory.

On a new test for the nitrates. By G. C. SCHAEFFER, Prof. of Chemistry in Center College, Ky. Read, with comments, by T. S. HUNT.

On the assumed existence of Ammonia in the general atmosphere. By AUG. A. HAYES, M.D., Asssayer to the State of Massachusetts. Presented by Dr. C. T. JACKSON.

Allanite of Franklin, N. J. By Dr. C. T. JACKSON.

Telluret of Bismuth and Gold. By Dr. C. T. JACKSON.

On the manufacture of Zinc and Zinc white. By Dr. C. T. JACKSON.

Analysis of red marl of Springfield, Mass. By Dr. C. T. JACKSON.

Zircon, Sodalite, Cancrinite, &c., Litchfield, Me. By Dr. C. T. JACKSON.

Analyses relative to the economical value of Anthracite Coal Ashes. By JONATHAN B. BUNCE, Yale Laboratory.

On the relation of the chemical constitution of bodies to taste. By Prof. E. N. Horsford, Harvard.

On the connection between the chemical constitution of bodies and color. By Prof. E. N. Horsford.

On the Spheroidal State. By Prof. Horsford.

On the adulteration of Vermilion. By Henry Brown, Cambridge Laboratory.

Ammonia in Atmospheric Air. By Prof. E. N. Horsford.

Analysis of Phlogopite from St. Lawrence Co., New York. By Wm. J. Craw, Yale Laboratory.

Determinations of Nitrogen in two varieties of Indian Corn. By Wm. H. Brewer, Yale Laboratory.

Analysis of the ash of Sweet Corn. By Wm. H. Brewer.

An account of some experiments upon the cause of fermentation. By Dr. Henry Erni.

On American Spodumene. By George J. Brush.

On some peculiar properties of a compound of Lard and Rosin. By Prof. D. Olmsted, Yale College.

Notice of two American Meteoric Irons. By Prof. B. Silliman, Jr.

Proper height of Lightning Rods. By Prof. Elias Loomis, New York University.

On Rutile in Quartz and other Minerals. By Prof. O. P. Hubbard, Dartmouth College.

17. *Proceedings of the American Association for the Advancement of Science;* Third Meeting, held at Charleston, S. C., March, 1850. 216 pp. 8vo.—This volume made its appearance in time to greet the members of the Association at their recent meeting in August; and, considering the short interval since the adjournment at Charleston, the vote of thanks from the Association to the Secretary, Prof. Lewis R. Gibbes, for his superintendence of the work, was doubly due him. At this time we can mention only a list of the papers brought before that meeting.*

Catalogue of Plants inhabiting the vicinity of the Santee Canal, S. C. By H. W. Ravenel, Esq.

On the influence arising from the discovery of the Gulf Stream upon the Commerce of Charleston. By Lieut. M. F. Maury.

On the exudation of ice from the stems of Vegetables. By Prof. John LeConte.

Characteristics of the Hindoo Skull. By S. Kneeland, Jr.

On Meat Biscuit. By G. Borden, Jr.

Report of Committee on the communication of Lieut. Maury, upon Winds and Currents.

The Manatus not a Cetacean but a Pachyderm. By S. Kneeland, Jr.

A simple demonstration of the theorem, that the attraction of a sphere upon an exterior particle is the same as if the sphere were concentrated at its centre. By Prof. James H. Coffin.

On some of the applications of Natural Science to the moral laws of ancient nations. By Dr. J. H. Gibbon.

* The asterisk where used below, signifies that an abstract of the memoir was not handed to the Secretary for publication in the Proceedings.

Results of observations on the direction and force of Wind at the Coast Survey Stations. By Prof. A. D. Bache.

On the application of the Electro-Chronograph in determining the figure and density of the earth. By Lieut. M. F. Maury.

Remarks on preceding paper by Prof. L. R. Gibbes; fitness of Stone Mountain, Ga., for such observations; smallest interval appreciable by the ear between the beats of two chronometers.

On the existence in some individuals of two Insensible spots on the Retina. By Prof. Lewis R. Gibbes.

Researches on the generation and development of the Opossum. By Dr. Myddelton Michel.

Remarks of Prof. L. Agassiz on preceding paper; necessity of further details.

Remarks of Rev. Dr. Bachman on the same paper; vigor and power of suction of young opossum, just taken from the uterus.

On the Palæozoic Rocks of Alabama. By Prof. M. Tuomey.*

On the peculiar sensations produced by a damp atmosphere. By Dr. W. L. Jones.

On the Fossil Equus. By Dr. Robert W. Gibbes.

Remarks on the preceding paper. By F. S. Holmes. No fossil mammalian remains except cetacean, in the Eocene marl of So. Ca.

On the Northern Elephas, and on Mastodon angustidens. By Dr. R. W. Gibbes.

On Fossils common to several Formations. By Dr. R. W. Gibbes.

Remarks on the preceding paper by Prof. Agassiz and Prof. Tuomey; the species common to two or more strata are very few.

On the air bladder of the Drum-fish, Pogonias fasciatus, and the mechanism by which the sound is produced. By Dr. J. E. Holbrook.*

Remarks on the preceding paper by Prof. Agassiz; development of air bladders.

Remarks on the paper of Prof. Tuomey, of yesterday, by Dr. E. Ravenel and Lieut. Maury; importance of the coal fields of Alabama to the navigation and commerce of the Pacific.

Remarks on the paper of Dr. R. W. Gibbes, of yesterday, by Prof. Agassiz; the species common to different formations are very few, mistakes in this respect are attributable to geological error.

Exhibition of a fossil reptile belonging to the genus Leiodon. By Prof. Tuomey.

On the Currents of the Atlantic Ocean. By Lieut. M. F. Maury.

Remarks on the preceding paper by Prof. Agassiz; or the fancied importance of the name of the first describer of a species.

On the Marine Flora of the Atlantic. By Prof. W. H. Harvey.

On the comparative reflecting power of the Planets, Mars, Jupiter and Saturn. By Prof. Lewis R. Gibbes.

Distribution of the Foraminifera on the Coast of New Jersey. By F. de Pourtales.

Remarks on this paper, by Prof. Agassiz; the aid rendered to Naturalists, by the Coast Survey.

On the order of Succession of parts in Foraminifera. By F. de Pourtales.

On the Principles of Classification in Zoology. By Prof. Agassiz.

On the American species of the genus Putorius. By the Rev. Dr. BACHMAN.*

On the alleged subsidence of the Coast of South Carolina. By Prof. TUOMEY.*

Examination of the Physical History of the Jews, in its bearings on the question of the Unity of the Races. By Dr. J. C. NOTT.

Remarks of Prof. AGASSIZ, after the reading of this paper; zoological evidence for the diversity of the Races.

Microscopic examination of the Pile of the Head of Albinos. By P. A. BROWNE, Esq.

On an easy mode of illustrating the difference in the Velocity of Sound in Gases. By Prof. LEWIS R. GIBBES.

On the Morphology of the Medusæ. By Prof. AGASSIZ.

Recent Progress of the Telegraph Operations of the United States Coast Survey. By Prof. A. D. BACHE.

On the General Circulation of the Atmosphere. By Lieut. M. F. MAURY.

Measurement of the Base Line on Edisto Island, S. C. By Prof. A. D. BACHE.

Account of three new American Meteorites, and geographical distribution of such bodies generally. By Prof. C. U. SHEPARD.

On the Structure of the Bones of Siren lacertina. By Dr. ST. JULIEN RAVENEL.*

On a new species of Menobranchus, from South Carolina. By Prof. LEWIS R. GIBBES.

On the recent Squalidæ of the Coast of South Carolina, and Catalogue of the Recent and Fossil Echinoderms of South Carolina. By Dr. EDMUND RAVENEL.

On the Cretaceous Formation of Alabama, and the Artesian Wells in that State. By Prof. TUOMEY.*

On the Resistance of Timber. By H. HAUPT.

On the Carcinological Collections of the United States, and descriptions of new species. By Prof. LEWIS R. GIBBES.

On the Morphological Differences of Organs. By Prof. L. AGASSIZ.*

Meteorological and Mortuary Chart of New Orleans, for 1849. By Dr. E. H. BARTON.

Observations on the Geology of Ashley River, S. Carolina. By F. S. HOLMES.

Remarks on the preceding paper, by Prof. AGASSIZ; the large number of Mammalia in the Fossil Beds of South Carolina.

Proximate Composition of parts of Flowers of Plants, and of the Plants themselves. By Dr. J. H. SALISBURY.

On the Structure of the Halcyonoid Polypi. By Prof. AGASSIZ.

18. *Editorial note with reference to the article on the Electro-Chronograph, in Volume III.*—The article on the "Electro-Chronograph," which was published in this Journal for September of last year, contained allusions and imputations of an improper personal nature, reflecting discreditably upon the motives and veracity of some of the most eminent and unimpeachable among American laborers in science. We regret that these justly offensive portions escaped editorial notice at the time the article in question passed through the press. Our ob-

ject in alluding to the subject at this late day, (late because our attention was only recently called to it,) is, at once, to disavow on our own behalf all the expressions and passages of an offensive and personal nature which that article contains—to whomsoever they may apply—and at the same time to deprecate, in the most emphatic manner, all personalities in science, every instance of which we most earnestly desire to exclude from our pages. This statement we esteem in entire accordance with the limitation of editorial responsibility upon which we have uniformly acted, and which is fully expressed on page 151 of this volume.

OBITUARY.

19. M. DE BLAINVILLE.—At the funeral of M. de Blainville, which took place on Tuesday, the 7th of May last, a discourse was pronounced by M. Constant Prévost, another by M. Chevreul, and a third by M. Milne Edwards.—The following are some citations from the remarks of M. Prévost.

"But eight days since, on Tuesday last, at the same hour that now assembles us around this bier, I happened to be present at the last lecture of M. de Blainville. He was animated, full of his subject, and he entertained us for nearly an hour, exhibiting a freshness of ideas and facility of expression which bore no marks either of fatigue or apprehension. Some threatening symptoms had been experienced during the year past, but, with a force of character peculiar to him, he had sought to conceal them from all, and even from himself. Wednesday evening he proposed to visit his niece who was sick at Dieppe, intending to return in time for his lecture the following Saturday; but when about to start, he was found dead in the carriage where he had taken his seat but a few seconds before. * * * *

MARIE-HENRI DUCROTAY DE BLAINVILLE was born at Arques, September 12, 1778. A student of the military school of Beaumont near Touques, and destined, as a cadet of a noble family, to follow the career of arms, for some reason unknown to me he abruptly left the school in 1792. At the risk of his life he sought refuge on board a vessel cruising in the British channel and took part in several serious combats. Returning to France, M. de Blainville for some years of his youth, pursued with inconstant enthusiasm, an ardent imagination and an impetuous character, the study of different branches of literature and the arts. * * * *

At the age of twenty-seven (I believe) he was still undecided with regard to his future pursuits, when one day, as if by chance, or better, by the guidance of Providence, his vocation was irrevocably determined. He entered the college of France and heard a lecture by Cuvier. Struck at once with the interest of the subject and the eloquent words of the celebrated Professor, he left the building with the resolution to give himself to natural science and become a Professor. From this time his desultory habits were changed; in three years he went through courses of human anatomy and two years afterward (in 1810) he became a doctor of medicine. In 1812, having for some time assisted Cuvier at the College of France and at the Museum, he was appointed to the chair of Zoology, Anatomy and Physiology of the Faculty of Sciences; and in 1832, on the death of Cuvier, all eyes were upon M. de Blainville as

the only person fitted to be his successor in the department of Comparative Anatomy. Thus 28 years from the period when his resolve was made had sufficed to place him, through his own efforts alone, in this supreme position in Science." * * * *

20. CHRISTIAN VIII, KING OF DENMARK, (from the Anniv. Geol. Address of Sir C. Lyell, Quart. Jour. Geol. Assoc., No. 22, 1850.)—Christian VIII, King of Denmark was enrolled a Fellow of this Society in 1822. Two years before that time, when travelling in Italy, he had witnessed an eruption of Vesuvius, and had read a description of it to the Academy of Sciences at Naples; a communication published in their Transactions, and afterwards reprinted in Leonhard's Journal for 1822.

From an early age he had taken a lively interest in the progress of natural history, and when Crown Prince, formed at Copenhagen, at his own expense, a magnificent collection of shells, the number of species being estimated at not less than 12,000, exclusive of fossils. When I visited the Danish capital in 1835, he placed this museum and his library at my disposal, and I had then an opportunity of knowing that he kept up an acquaintance with the new species added from year to year to his cabinet, then in charge of an able conchologist, Dr. Beck, and that he was very desirous of making his museum useful to all zoologists. Nor was he inattentive to the points of controversy then agitated respecting the geology of Denmark. He questioned me closely as to my opinion, whether the strata of Faxoe, containing certain species of *Cyprea*, *Oliva*, *Mitra*, and other genera usually regarded as characteristic of the tertiary period, really belonged to that epoch, or to the cretaceous rocks. That the latter conclusion was correct I had satisfied myself, after exploring the cliffs of Moën and Seeland, as I have explained in your Transactions; and you are aware that the Faxoe beds, together with those of Maestricht and Sezanne near Paris, have been recently classed as an upper member of the great cretaceous system.*

When Christian VIII. succeeded to the throne, the cares and duties of an absolute monarch did not make him forgetful of his former love for natural history. He was always accessible to scientific foreigners and natives, and set on foot several publications, among which I may mention the 'Gæa Danica' of Professors Steenstrup and Forchhammer. He also gave his patronage to a splendid botanical work on the palms of Mexico, by Professor Liebmann, and promoted liberally the geological expedition of Baron von Waltershausen and Professor Bunsen to Iceland. He also took care that a good naturalist should accompany the voyage of the Galathea around the world; and when that expedition returned, he directed that the valuable collections, made by the officers in various countries, should be divided equally between the Universities of Copenhagen and Kiel. As Crown Prince, he had been elected President of the Academy of Sciences at Copenhagen, and when he attended their meetings, after his accession to the throne, he always declined to be received as king, taking his place simply as a member, or as any other President. After a reign of nine years, he died in January, 1848.

* Geol. Trans., 2nd series, vol. v, p. 249.

21. Darius Lapham.—Mr. Lapham, at the time of his death (August of the present year), was Canal Collector at Cincinnati, and member of the State Board of Agriculture. He had charge of the preparation of the grounds for the State Fair, to be held in September.

In the death of Mr. Lapham the State Board of Agriculture has lost one of its most valuable members, and the State one of its best citizens. His death will be deplored by a very large circle of friends, to whom he was warmly attached for his many virtues, and modest, retiring deportment. It is but a few days ago that we received a letter from him, giving quite an encouraging account of the progress he was making in the extensive preparations for the State Agricultural Fair. To-day he is numbered with the dead.—*Ohio Statesman.*

22. Dr. Troost.—Gerard Troost, M.D., Professor of Chemistry, Geology and Mineralogy in the University of Nashville, after a protracted illness, departed this life on the 14th of August, at 1 o'clock, P. M.

Born and liberally educated in Holland, he early manifested a zealous devotion to Natural History and Chemistry, and more especially to the then infant sciences of Geology and Mineralogy. With a view to the more successful prosecution of his favorite studies, he visited Paris, and, for several years, was a pupil of the celebrated Haüy. He removed to the United States about forty years ago; and, in due time, became an American citizen. His entire life was consecrated to Geology and the kindred sciences. With what ability and success, his published writings and his well-earned reputation at home and abroad, may eloquently testify.

As a Professor in this University, during the last twenty-two years, and as the State Geologist of Tennessee for most part of that period, he won the confidence and respect of the community, by invaluable services in both capacities, as well as by the unaffected modesty, kindness, and uniform courtesy of his deportment towards all men. In the various stations and relations of life, public and private, he was without reproach and above suspicion. Beloved, trusted, honored, venerated, by all those most intimately connected or associated with him, he could not make an enemy—he had none.—(From the Proceedings of the Board of Trustees of the University of Nashville.)

V. Bibliography.

1. *Tabulæ Atomicæ: Chemical Tables for the Calculation of Quantitative Analyses of H. Rose*, recalculated for the more recent determinations of atomic weights, and with other alterations and additions, by William P. Dexter. 70 pp. 8vo. Boston: Little & Brown. 1850. —The Tables of Atomic Weights by Rose are well known to chemists and fully appreciated. The author of this American edition has not simply given us a reprint of Rose. As the atomic weights of several of the elements have been changed through the recent investigations of chemists, a large amount of recalculations became necessary both in the numbers for the compounds of the elements whose atomic numbers have been redetermined, and for very many other elements whose equivalents were based on those that have been altered. To insure perfect accuracy, the calculations, as the author states, were performed by himself both directly and by logarithms;

and the columns of multiples were computed separately by himself and another. From the care thus taken, and the thorough knowledge which the author possesses, we may feel fully assured of the correctness of the work. Those atomic weights have been taken that were deemed most trustworthy, the determinations of Berzelius, being allowed, as by Rose, the greatest weight; some recent determinations have been rejected for want of confirmation. A column of logarithms has been added to the tables by Mr. Dexter. A large part of the compounds given in Rose's work under chlorine and sulphur have been omitted, as they were "of comparatively little practical use." The volume commences with an introduction of a dozen pages, consisting of observations on the numbers adopted, and their authorities. The author has verified the calculations from the chemical data furnished by different experimenters, and observes that in some cases he has detected a small error of computation. The number determined for titanium by Berzelius from Rose's analyses is 301·55, while it should be 301·304. In a similar manner the number for osmium was found to be 1243·624, instead of 1242·624; that of tungsten should be 1183·36, instead of 1188·36; that of phosphorus as computed by Berzelius is 392·041, while it should be 391·72. The tables are printed in a fair open type and are easy of reference.

2. *First Biennial Report on the Geology of Alabama;* by M. Tuomey, Geologist of the State; Professor of Geology, etc., in the University of Alabama, 176 pp. 8vo. Tuscaloosa, 1850. M. D. J. Slade. —Prof. Tuomey presents in this Report the results of a general reconnoissance of the State, mentioning its great geological features and its resources, in order to show what is required for future explorations and the importance which attaches to the survey. The results obtained exhibit the state as rich in various mineral products as well as in facts of geological interest, and we shall look for much profit and instruction from its full survey by one so capable and so exact in observation. The following facts are from this first biennial Report.

Metamorphic Rocks enter Alabama from the upper corner of Carroll county; their northwest boundary passes through the southeast corner of Benton county, thence southwesterly three or four miles east of the town of Talladega, and crossing the Coosa above Fort Williams, it runs through the lower corner of Antauga county. The part of the state east of this line is wholly covered by these rocks. In the bed of the Coosa they are laid bare as low as Wetumpka, which, as observed by McClure, is the most southern exposure of this important group of rocks in the United States. The gold-bearing rocks extend from Randolph to Antauga. A white and gray marble is quarried near Talladega creek and worked for ornamental purposes. Some of the pure white is of fine quality, little inferior to the Italian, and blocks thirty inches in thickness may be procured.

A Silurian limestone is seen at Centreville on the Catawba, which forms the southern extremity of the Silurian System of Alabama, and probably of the United States. To the east, Silurian rocks spread out towards the Coosa in Antauga and Shelby, until they cover the metamorphic rocks in Talladega, Benton and Cherokee counties. Along the Coosa they make their appearance on the east, coming out from under the Carboniferous rocks of the Cahawba Valley, and higher up

in the same manner at the Lookout Mountain, whence they extend to Rome in Georgia. Sixteen miles southeast of Tuscaloosa they are visible, and thence they stretch north to the head of Murphree's Valley, separating the Warrior coal field on the west from that of the Cahawba on the east; and in this direction they are confined to a series of continuous valleys. They constitute a range of hills known as the "Red Mountains," so called from the presence of a bed of red oxyd of iron. Other small patches are mentioned, and further explorations will probbly enlarge this extent of Silurian beds. The red iron ore consists of grains mostly flattened, like the lenticular argillaceous ore of New York. In some places it passes into a conglomerate containing siliceous pebbles. A bed of brown hematite occurs on Shultz Creek, also near the headwaters of Hurricane and Rockcastle Creeks twenty-four miles from Tuscaloosa, and at Bucksville.

Heavy spar occurs in a vein a foot or two thick, near Pratt's Ferry on the Cahawba, and in another similar above Elyton. It is ground up for white paint.

The carboniferous rocks cover all that part of the state above the lower falls of the rivers, not already described as belonging to the Red Mountain group. The greatest development of the calcareous beds enters Alabama as a prolongation of the Cumberland Mountains. Caves abound in these rocks, and the earth frequently contains nitrates, from which nitrate of potash is obtained. The coal measures every where rest on millstone grit. The mountains of Madison and Jackson counties and the hills of Morgan and Marshall counties are often capped with sandstones and shales containing beds of coal. The Raccoon and Lookout Mountains have coal beds of considerable extent. These connect with the measures of the Locust Fork of Warrior creek, and the Cahawba, while the isolated patches of the hills in Morgan and Lawrence run into those of the Sipsey and Mulberry Forks, in such a manner as to leave no doubt of their being parts of one continuous and vast coal field. The St. Clair coal field on the Coosa, connected with the Cahawba on the southwest contains about 150 square miles. The Cahawba coal field is bounded on the south and east by the Little Cahawba and its tributary, Shoal Creek, on the east by Shades Creek as low as Bucksville, and reaches within two miles of Montevallo and within three miles of the river at Lacy's Ferry. It contains 180 to 200 square miles. The Warrior coal field occupies the region drained by the Warrior river and its tributaries, covering for the most part the counties of Walker, Blount, Jefferson and Tuscaloosa, and having an area of about 5000 square miles. The carboniferous rocks of DeKalb, Morgan and Lawrence counties have not yet been explored. The Tuscaloosa coal has been long in use in the state.

The Report continues with observations on the cretaceous and tertiary rocks.

3. *A Treatise of Plane and Spherical Trigonometry;* by WILLIAM CHAUVENET, A.M., Professor of Mathematics in the United States Naval Academy. pp. 256, 8vo. Philadelphia: Henry Perkins. 1850.—In this treatise, the author as he states in the preface, has undertaken "to arrange a course of trigonometrical study sufficiently extensive to enable the student to comprehend readily any applications of trigonometry he may meet with in the works of the best modern mathema-

ticians." For this purpose it was necessary to extend the treatise much beyond the ordinary limits of the elementary text-books used in academies and colleges. But the author has sought to adapt his work for the use of College classes, by putting the elementary matter in larger type, so that it may easily be read independently of the other portion of the book. A complete and well arranged treatise of trigonometry has been greatly needed for the use of mathematical teachers, and of practical astronomers, surveyors, engineers, &c. No work of this kind has before been published in this country; and we know of no English work in which the subject of spherical trigonometry especially, is presented in a satisfactory manner. Many useful formulæ now commonly employed in astronomical investigations are not to be found in the larger and more recent treatises of trigonometry published in England. These deficiencies are well supplied in the work of Mr. Chauvenet: and from the examination we have been able to make we are satisfied that it will prove a more convenient and useful manual for the mathematical teacher and the practical mathematician than any similar English or American work. It would perhaps have been somewhat better for purposes of reference, if the author had added tables in the customary way, giving a synoptical view of the more useful trigonometric formulæ.

4. *A descriptive account of the Freshwater Sponges of the Island of Bombay with observations on their structure and development;* by H. J. Carter, Esq., Assistant Surgeon, Bombay Establishment, 22 pages, 8vo, with 3 plates, (from the Jour. Bombay Branch of the Roy. Asiat. Soc., No. xii, 1849.)—The author in this paper describes 5 species of Spongilla—the S. cinerea, alba, Meyeni, plumosa, new, and the S. friabilis? of Lamarck. With regard to them he observes that in each species excepting the *cinerea* they cannot be said to be characterized by any particular form. The memoir contains interesting details respecting the structure and development of the sponge, many of which are exceedingly curious. The memoir is illustrated by good engravings showing well the structure and the varying forms of the sponge cell.

We cite the following observations on the sponge cell, which are exposed on tearing a newly formed sponge, and the protean cells developed from the contents of the seed-like bodies when forcibly expelled.

"The sponge-cell when *in situ*, is ever changing its form, both partially and wholly; its granules also are ever varying their position with, or independently of the movements of the cell, and its pellucid vesicle or vesicles, dilating and contracting themselves or remaining passively distended, and exhibiting in their interior molecules of extreme minuteness in rapid commotion. When first separated from the common mass, this cell for a short time assumes a globular form and afterwards, in addition to becoming polymorphic, evinces a power of locomotion. During its polymorphism it emits expansions of its cell-wall in the form of obtuse or globular projections, or digital and tentacular prolongations. If in progression it meets with another cell, both combine, and if more are in the immediate neighborhood, they all unite together into one common globular mass. Should a spiculum chance to be in the course of a cell, it will ascend it and traverse it from end to end, subsequently quitting it or assuming a globular form, embrace some part of

it and remain stationarily attached to it. The changes in shape and position of the sponge-cell and its intercellular mucilage are for the most part effected so imperceptibly, that they may be likened to those which take place in a cloud. Its granules however are more active, but there appears to be no motion in any part of the cell, excepting among the molecules within the hyaline vesicle, which in any way approaches to that characteristic of the presence of cilia.

"It should be understood however, that these remarks are not applicable to every sponge-cell, although fully developed, which appears in the field of the microscope, but they are rather a statement of what a sponge cell may evince, than of what every sponge-cell does evince.

"The polymorphic cells or proteans which appear in the watch-glass after the contents of a seedlike body have been forcibly expelled into it under distilled water, are much more active in their movements. Their cell-walls frequently assume the most fantastic figures, spheroidal, polygonal, asteroid, dendritic, &c. Their green granules move backwards or forwards, to this side or to that with great activity, as the part of the cell to which they are attached is entrained in one direction or another; while their hyaline vesicle or vesicles (in progression) appear occasionally in every part, not only of the body of the cell, but in its tubular prolongations. The contraction of the hyaline vesicle seems to take place most frequently when it arrives at the posterior extremity, that is according to the direction in which the cell is progressing; next in frequency, at the sides, seldom in the anterior or central part of the mass. When contraction takes place, it is effected more or less completely, more or less suddenly; if complete, a dark speck or opacity marks the original position of the vesicle, in the centre of which, if watched, it may be observed to re-appear, and as it is carried forward in the movements of the cell with the portion to which it is attached, it gradually regains its original size, and returning in due course to the point from which it started, again contracts as before.

"In progression, some of the large proteans developed in the way just mentioned appear to be conscious of the nature of certain objects which they encounter in their course, since they will stop and surround them in their cell-wall. It is not uncommon to see a portion of a spiculum in the latter position, the larger germs of the sponge itself, the body of a loricated animalcule the 900th part of an inch in diameter, on which the pressure exerted by the protean may be seen by the irregular form assumed by the animalcule the moment it has become surrounded. I once saw one of these proteans approach a gelatinous body, something like a sluggish or dead one of its own kind, and equal to itself in size, and having lengthened itself out so as to encircle it, send processes over and under it from both sides, which uniting with each other, at last ended in a complete approximation of the two opposite folds of the cell-wall, throughout their whole extent, and in the enclosure of the object within the duplicature. Even while the protean was thus spreading out its substance into a mere film, to surround so large an object, a tubular prolongation was sent out by it in another direction to seize and enclose in the same way, a large germ which was lying near it. After having secured both objects, the protean pursued its course, rather more slowly than before, but still shooting out

its dentiform processes with much activity. It took about three quarters of an hour to perform these two acts."

5. *Recherches Anatomiques et Zoologiques faites pendant un Voyage sur les cotes de la Sicile et sur divers points du littoral de la France;* par MM. MILNE EDWARDS, A. DE QUATREFAGES and EMILE BLANCHARD. 3 volumes, 4to, with numerous plates.—These volumes consist of a series of memoirs on the structure, development and physiology of various animals in different departments of zoology. They are the result of investigations of the most minute microscopic character pursued by the first zoologists of France; the observations are profound, and exact, and the illustrations unsurpassed for fullness and beauty. The *First* volume, by MILNE EDWARDS, contains memoirs on the development of Annelids, on the classification of the Gasteropodous Molluscs, and on the general subject of circulation; the *Second* by M. DE QUATREFAGES, treats of the nervous system and History of the Amphioxus, of the Pycnogonidæ, Phlebenterisma, Planariæ, the Nemertes, Echiurus Gærtnerii, with a review of the observations made in 1844 on the Gasteropoda Phlebenterata; the *third* by M. BLANCHARD, is occupied with a memoir of 336 pages on the organization of Vermes, especially the subdivision "Entomozoaires apodes" of Blainville. Many of these memoirs have appeared in some of the later volumes of the Annales des Sciences Naturelles.

6. *Les Alpes, Journal des Sciences Naturelles, Agricoles, Medicales, Physiques et Astronomiques,* contenant un résumé de tous les travaux qui concernent la Suisse et la Savoie et de tous ceux qui sont publiés dans ces deux pays.—Issued in a sheet of 8 quarto pages, on the 1st and 15th of each month. This periodical made its first appearance on the 1st of July last. It is edited by *Gabriel Mortillet* ingénieur civil à Genève, place de la Fusterie, 78 au 2me. The subscription price for foreigners is 12 francs a year. The object of this Journal is to give a brief review of all new scientific matters relating to Switzerland and Savoy and also of whatever may be published in these countries.

G. HECK: Iconographic Encyclopedia of Science, Literature and Art, the text translated and edited by Prof. Spencer F. Baird, and published by R. Garrigue, New York. Part 10, the text on Botany.

ARNOLD GUYOT: The Earth and Man, 2d edition. *Boston*, 1850.

A. DUBREUIL: Cours Elementaire théorique et pratique d'Arboriculture. 2d edition. *Paris.* 9*fr.*

A. D'ORBIGNY: Cours Elémentaire de Palæontologie et de Géologie Stratigraphiques. 2 vols. 18mo, with 500 figs. in the text and 18 tables in 1 atlas 4to. *Paris.* 10*fr.*

A. D'ORBIGNY: Prodromus de Palæontologie Stratigraphique Universelle. 3 vols. 8vo. *Paris.* 24*fr.* Volume 1 is on sale for 8 francs.

LIEUT. M. L. SMITH and CAPT. E. L. F. HARDCASTLE: Map of the Valley of Mexico with a plan of the defences of the Capital and the line of operations of the U. S. Army under Major General Scott, in August and September, 1847. Surveyed and drawn by Lt. M. L. Smith and Brevt. Capt. E. L. F. Hardcastle, U. S. Top. Engineers, (Senate U. S., Ex. Doc. No. 11.)

LIEUT. SIMPSON, U. S. A.: Report and Map of the route from Fort Smith, Arkansas, to Santa Fe, New Mexico, made by Lt. Simpson. (U. S. Senate, Ex. Doc. No. 12.)

A MAP showing the operations of the Army of the U. States in Texas and the adjacent Mexican States on the Rio Grande: accompanied by astronomical observations, and descriptive and military memoirs of the Country. From the "Topographical Bureau." *Washington.*

BRITISH ASSOCIATION: Report, for the Nineteenth Meeting, Sept., 1849. 8vo. 11 plates. 1850. 10*s.*

R. Deakin: Florigraphia Brittanica, or Engravings and Descriptions of the flowering plants and Ferns of Britain. 4 vols. 8vo. Vols. 1–3 each 30*s.* or colored 57*s.* 6*d.* vol. 4 14*s.*, colored 16*s.*

M. V. Regnault: Elements of Chemistry, in course of translation from the French and to be published by Hogan & Thompson, *Philadelphia.*

L. Agassiz: The Classification of Insects from Embryological data. From Vol. II, Art. 6. of the Smithsonian Contributions to Knowledge.

P. Joigneaux: La Chimie du Cultivateur. 1 vol. 18mo. *Paris.* 2*fr.*

Liebig and Kopp: Annual Report of the Progress of Chemistry for 1847–48. Part V, containing Chemistry applied to the Arts and Manufactures, Agricultural Chemistry, Mineralogy and Geology. *London.*

The Astronomical Journal, Cambridge. NO. 11, June 27, 1850.—On the 5th Comet of 1847; *B. A. Gould, Jr.*—1st Comet of 1850.—On the employment of the theorem, "small angles are proportional to their sines;" *Prof. W. Chauvenet.*—New Planet.—From letters of Prof. Schumacher to the Editor.—Colors of Stars; *Prof. B. Sestini.*—NO. 12, July 17. Colors of Stars; *B. Sestini.*—Parthenope.—Elements and observations of the 1st Comet of 1850.—From a letter of Dr. d'Arrest.—Observations of Petersen's Comet of 1850 with the filar-micrometer of the Washington equatorial; *J. Ferguson.* NO. 13, July 26.—Great Comet of 1844–45; *G. P. Bond.*—From a letter of Prof. Curley.—Letter of Lieut. Maury.—Comet observations. NO. 14, Aug. 9.—Determination of the velocity of the Galvanic Current by means of the Electro-chemical Telegraph; *S. C. Walker, Esq.*—From letters of Prof. Schumacher.—Observations of Petersen's Comet, made at the Cambridge Observatory, 1850.—Occultations of Aldebaran, Jupiter and Regulus, observed at the Cambridge Observatory in 1848, 1849, 1850.

Proc. Bost. Soc. Nat. Hist.—*February*, 1850. p. 241. Comparative value of American Sandstone; *Mr. Alger.*—p. 242. The Walrus related to the Pachyderms; *J. Wyman.*—p. 242. Remarks on the relation of the alluvium to the drift of the Mississippi; *Desor.*—p. 243. Analysis of Vermiculite by R. Crossley and description by *C. T. Jackson.*—p. 247. Jacksonite identical with Prehnite; *C. T. Jackson.*—p. 248. Origin of the green sand of New Jersey; *H. D. Rogers. March.*—p. 251. New Planariæ of the Coast of Massachusetts; *Girard.*—p. 252. New Shells of the Exploring Expedition (1 species of Erycina, 6 of Tellina, 1 Psammobia, 3 Donax, 4 of Lucina); *A. A. Gould.*—p. 256. On Green Sand.—p. 257. Shark's tooth from limestone at Keokuk, Iowa; *Desor.*—p. 259. Capacity of the Cranium of the Troglodytes niger; *Kneeland.*—Origin of Salt lakes; *H. D. Rogers.*—p. 260. Some observations on Palms from Singapore; *Teschemacher.*—p. 262. Embryology of Articulata; *Burnett.*—p. 264. Two marine Planariæ and several freshwater species; *Girard.*—p. 266. Crystals of Gold from California; *F. Alger. April.*—p. 272. On an Aztec Skull; *Dr. Kneeland.*

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